USACHPPM

Prevention and Control of Plague

Technical Guide 103

September 1995

U.S. Army Center for Health Promotion and Preventive Medicine
Direct Support Activity - West
Fitzsimons Army Medical Center
Aurora, Colorado 80045-5001

This Technical Guide is dedicated to Dr. Allan M. Barnes, whose inspiration and knowledge helped the author to better understand plague.

For information or technical assistance concerning plague or questions concerning the contents of the document, contact:

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PREFACE

This document is for individuals, including personnel from the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM), who participate in installation plague prevention and control programs. The general guidance contained herein should be tailored to meet local needs.

As the epidemiology of plague is constantly changing, the information on prevention and control strategies and methodologies is constantly undergoing revision. Thus, in addition to using this technical guide, you should seek information from local, state and Federal sources as necessary.

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CHAPTER 1

PLAGUE THREAT ON MILITARY INSTALLATIONS

1-1. Plague infection

a. Plague can infect a wide variety of wild and domestic animals, although some species are much more susceptible than others. Plague is believed to circulate in small rodent populations such as mice, rats, and chipmunks, causing little mortality. Known, probable, and susceptible primary maintenance hosts of plague include rodent species that exhibit:

(1) Moderately high resistance to plague.

(2) Broad heterogeneity to challenge with *Yersinia pestis* within a population.

(3) Long multiestrous breeding season with successive multiple litters and high reproductive potential.

(4) Short natural life expectancy and a high replacement rate of individuals in a population.

b. Occasionally, populations of more susceptible mammals (e.g., prairie dogs, rock squirrels and California ground squirrels) are infected with plague. These rodents live, for the most part, in colonies covering large areas of land. When a plague outbreak within these colonial rodent populations occurs, the potential for human exposure to infected mammals and fleas increases greatly. Plague-susceptible rodents are called "amplifying hosts" because they are highly infective and enable the disease to spread rapidly.

1-2. Plague on military installations

a. Characteristics. Exposure to plague on military installations can be characterized by three general scenarios:

(1) Pets (dogs and cats) that are allowed to run free bring plague infected rodents or their fleas into housing areas. Cats can also develop plague and subsequently transmit the disease through bites, scratches, etc.

(2) People using recreation areas come into contact with sick or dead rodents (plague infected) or plague infected fleas from rodent burrows. Hunters and trappers are included in this category, but they often face additional plague exposure during the handling and skinning of infected animals.

(3) Troops use field training/bivouac sites that have colonies of plague infected rodents. The potential for plague exposure is even greater where plague has killed the rodents, leaving live, plague infected fleas in the burrows.

b. Consequences. The consequences of plague on an installation may include:

(1) Human illness and/or death from plague. This not only causes anguish and concern among victims and relatives, but may also be politically sensitive.

(2) Illness or death of pets or other desirable animals.

(3) Lost use of training/bivouac sites. This is particularly serious since most plague outbreaks occur during the summer months when field training is intensified.

(4) Large expenditures of money, manpower and equipment to reduce or eliminate exposure following a plague outbreak.

(5) Lost use of recreation areas. This can be serious since these areas show increased use in the summer when plague outbreaks tend to occur.

1-3. Prevention and control principles

Plague is a dynamic disease with many variables including a wide variety of animal hosts/reservoirs; numerous flea species with varying abilities to transmit the plague organism; geographic differences and relationships between rodents, fleas, and habitats; and different infection rates/resistance to plague in rodents. For these reasons there is no one strategy for the prevention and control of plague that will work at all locations. However, the following principles, modified to fit each location (installation), should be adhered to:

a. Surveillance of plague susceptible rodent populations and rodent predators.

b. Control of plague susceptible rodents and their fleas.

c. Reduction of human and pet exposure to susceptible rodents and their fleas in plague endemic areas.

d. Public education and awareness concerning plague.

1-4. Potential plague risk

The following outlines the potential plague risk to humans on specific Army installations.

a. Fort Bliss, Texas.

(1) *Location of rodents.* Several colonies of black-tailed prairie dogs (*Cynomys ludovicianus*) are located near McGregor Range about 50 miles from the cantonment area.

(2) *Exposure potential.* There is usually no human activity in this area. Likewise, no highly plague susceptible rodent populations are found near or around recreation areas.

(3) *Occurrence of plague.* Plague has not been detected on the installation; however, it has been found in some of the surrounding counties.

b. Fort Carson, Colorado.

(1) *Location of rodents.* Numerous colonies of rock squirrels (*Spermophilus variegatus*) and black-tailed prairie dogs occur throughout the installation. Several large prairie dog colonies are also located adjacent to the main cantonment area.

(2) *Exposure potential.* Military personnel who participate in field maneuvers may have contact with these rodents. Personnel and domestic animals could be exposed to plague in the cantonment area if an epizootic occurs.

(3) *Occurrence of plague.* Plague has been isolated on the installation.

c. Dugway Proving Ground, Utah.

(1) *Location of rodents.* Rock squirrels are known to occur on the installation; however, their distribution has not been determined by this Center.

(2) *Occurrence of plague.* Carnivore serologies indicate plague has been active on or near the installation.

d. Fort Huachuca, Arizona.

(1) *Location of rodents.* Numerous rock squirrel colonies are located throughout the Huachuca Mountain Range.

(2) *Exposure potential.* Housing, work and recreation sites are located within these areas. Personnel and domestic animals may be exposed to plague if an epizootic occurs. Troop activities, however, usually are located away from rock squirrel habitats.

(3) *Occurrence of plague.* Plague has not been detected within or near the Fort Huachuca area.

e. Fort Hunter Liggett, California.

(1) *Location of rodents.* California ground squirrels (*Spermophilus beecheyi*) are found throughout much of the flat and low hilly areas of the installation. Colonies are also located within the cantonment area and within recreation sites.

(2) *Exposure potential.* Personnel who participate in field maneuvers may have contact with these rodents. Personnel and domestic animals could be exposed to plague within the cantonment area and recreation sites if an epizootic occurs.

(3) *Occurrence of plague.* Plague has been found on the installation; one human case has been reported.

f. Fort Lewis, Washington.

(1) *Location of rodents.* No highly plague susceptible colonial rodents have been collected on the installation. Norway rats (*Rattus norvegicus*) are susceptible commensal rodents that cause occasional problems.

(2) *Occurrence of plague.* Plague has not been detected on the installation; however, it has been found in other areas of the same county.

g. Navajo Army Depot Activity, Arizona.

(1) *Location of rodents.* Rock squirrels are located throughout areas where there are rocky outcroppings and talus slopes.

(2) *Exposure potential.* Some depot storage facilities (igloos) are located in and around these areas. Depot employees who enter these areas and reserve units training on the installation during summer months may have contact with these rodents.

(3) *Occurrence of plague.* Carnivore serologies indicate plague has been active on or near the installation.

NOTE: The Depot is operated by the Arizona National Guard. Following its closure as an active Army installation, Guard personnel will continue to operate the facility under State guidelines. Precautions should be taken with respect to plague for those training or working on the installation.

h. Fort Ord, California.

(1) *Location of rodents.* California ground squirrels are found throughout much of the flat and low hilly areas of the installation. These rodents are also found within the cantonment area and recreation sites.

(2) *Exposure potential.* Personnel who participate in field maneuvers may have contact with these rodents. Personnel and domestic animals could be exposed to plague within the cantonment area and recreation sites if an epizootic occurs.

(3) *Occurrence of plague.* Plague has been detected on the installation and has been isolated in other areas of the same county.

NOTE: Fort Ord now consists of a small annex centered around the Post Exchange/ Commissary Complex. However, military and Federal personnel still continue to work in the range areas. Although the number of personnel exposed to field rodents has been greatly reduced, the threat of plague still exists.

i. Pueblo Army Depot Activity, Colorado.

(1) *Location of rodents.* Black-tailed prairie dog colonies are located adjacent to the cantonment area, around security posts, and in depot storage areas.

(2) *Exposure potential.* Personnel who are involved in depot maintenance, storage or security could be exposed to plague in these areas if an epizootic occurs. Recreation sites are normally free of highly plague-susceptible rodents.

(3) *Occurrence of plague.* Plague has been isolated from rodents on the installation.

j. Camp Roberts, California.

(1) *Location of rodents.* California ground squirrels are found throughout much of the flat and low hilly areas of the installation. They are also found within the cantonment area and recreation sites.

(2) *Exposure potential.* Personnel who participate in field maneuvers may have contact with these rodents. Personnel could be exposed to plague within the cantonment area or recreation sites if an epizootic occurs.

(3) *Occurrence of plague.* Plague has not been detected on the installation but has been isolated in other areas of the same county.

k. Rocky Mountain Arsenal, Colorado.

(1) *Location of rodents.* Colonies of black-tailed prairie dogs are located throughout the installation.

(2) *Exposure potential.* Recreational sites are normally free of highly plague-susceptible rodents. However, workers involved in wildlife management, environmental monitoring, or pollution abatement may work in areas heavily populated with prairie dogs and may be exposed to plague.

(3) *Occurrence of plague.* Plague has been isolated from rodents on the installation; plague epizootics among prairie dogs have been documented.

NOTE: Because prairie dogs make up much of the prey base for endangered species of raptors on the installation, control of these rodents to reduce potential plague epizootics is severely limited.

l. Sierra Army Depot, California.

(1) *Location of rodents.* California ground squirrels occur throughout the cantonment area where there is tree cover.

(2) *Exposure potential.* Personnel and domestic animals could be exposed to plague in the area if an epizootic occurs.

(3) *Occurrence of plague.* Plague has not been detected on the installation, but it has been found in other areas of the same county.

m. Tooele Army Depot, Utah.

(1) *Location of rodents.* Colonies of rock squirrels occur throughout the installation where there is tree cover and within the sanitary landfill.

(2) *Exposure potential.* Personnel working at this site and in the sanitary landfill may be exposed to plague if an epizootic occurs.

(3) *Occurrence of plague.* Plague has not been detected on the installation; however, it has been found in other areas of the same county.

n. Umatilla Army Depot Activity, Oregon.

(1) *Location of rodents.* No highly plague susceptible colonial rodents have been collected on the installation. Norway rats, however, are a susceptible commensal rodent that are an occasional problem.

(2) *Occurrence of plague.* Plague has not been detected on the installation; however, it has been found in other areas of the same county.

o. White Sands Missile Range, New Mexico.

(1) *Location of rodents.* Rock squirrels and black-tailed prairie dog colonies are found only in very remote areas.

(2) *Exposure potential.* Personnel that enter these areas may be exposed to plague if an epizootic occurs.

(3) *Occurrence of plague.* Carnivore serologies indicate plague has been active on or near the installation.

p. Fort Wingate Army Depot Activity, New Mexico.

(1) *Location of rodents.* Rock squirrel colonies are located throughout areas where there are rocky outcroppings and talus slopes. Some storage areas are located in and around these areas. A colony of white-tailed prairie dogs (*Cymonym leucurus*) is also located in the storage area.

(2) *Exposure potential.* Personnel involved in maintenance, security and supply may be exposed to plague in these areas if an epizootic occurs.

(3) *Occurrence of plague.* Plague has been isolated from rodents on the installation.

NOTE: Fort Wingate has been closed as an active Army installation. Should this facility reopen or be used by Army personnel (e.g., training site), then precaution with respect to plague should be taken.

CHAPTER 2

PLAGUE EPIDEMIOLOGY

2-1. History

a. Worldwide. Epidemics and pandemics of plague have occurred since ancient times. There have been three major pandemics of plague. The first, the plague of Justinian, occurred during the 6th Century. The second, known as the black death, occurred during the 14th Century and claimed the lives of 25 million people (1/4 of the world population). The third pandemic began towards the end of the 19th Century and killed an estimated 10 million people. Smaller, sporadic epidemics have occurred between these pandemics such as the London epidemic of 1666 that killed 70,000 people. No other disease can compare to the devastating effects of plague in terms of the number of deaths and the degree of panic generated. Figure 2-1 shows the global distribution of plague. Table 2-1 lists the number of human plague cases by country from 1978-1992.

b. The United States. It is believed plague was introduced into the United States during the last pandemic aboard rat-infested ships. From 1900-1925, epidemics in port cities resulted in 493 human cases with 283 deaths that were associated with urban rat epizootics. Plague in the United States is now primarily a disease of small wild animals. Since 1925, human cases of plague have been sporadic and associated with wild animals or their fleas; usually, the victims have encroached upon the habitats of these animals. Human-to-human transmission has not occurred in the United States since 1924. Figure 2-2 shows the counties with positive plague samples from 1970-1994. Figure 2-3 shows reported human plague cases during the same period of time.

2-2. Distribution

a. Natural foci of plague are found throughout much of the world. In the United States, plague seems to be limited to the western third. Plague in wild animals is most commonly associated with pinon-juniper and pine-oak woodland habitats between 5,000-9,000 feet in elevation; however, plague is also found in many other habitats such as lower, dry grassland and desert shrub areas, the conifer forest of higher elevations, and the coastal wet temperate regions of the Pacific Northwest.

Table 2-1. Human Plague Cases by Country, 1978-1992*

	COUNTRY	CASES	DEATHS
AFRICA			
	Angola	27	4
	Botswana	173	12
	Kenya	442	20
	Libya	8	0
	Madagascar	1165	283
	South Africa	19	1
	Uganda	493	30
	Tanzania	4486	367
	Zaire	1349	355
	Zimbabwe	5	3
	Total	**8179**	**1075**
AMERICAS			
	Bolivia	267	29
	Brazil	707	9
	Ecuador	83	3
	Peru	697	63
	United States	230	34
	Total	**1984**	**138**
ASIA			
	China	240	77
	Kazakhstan	7	3
	Mongolia	31	12
	Myanmar	1311	22
	Viet Nam	3104	124
	Total	**4693**	**238**
World Total		**14856**	**1337**

* *Source: World Health Organization. Weekly Epidemiol Record. 1994; 2:8-10.*

Figure 2-1. Global Distribution of Plague (Courtesy of CDC, Ft Collins, CO)

Compiled from WHO, CDC, and country sources

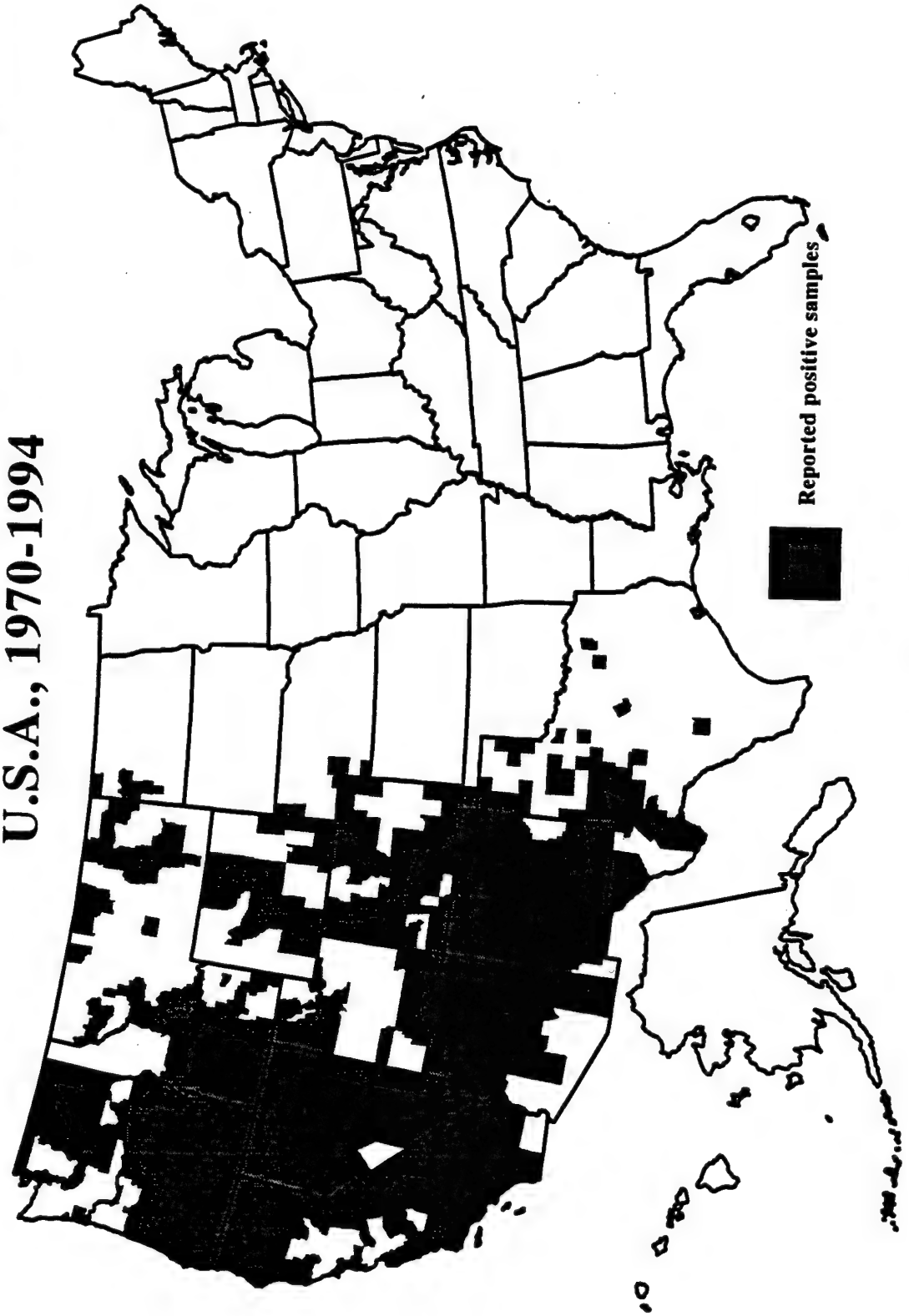

Figure 2-2.

(Courtesy of CDC, Ft Collins, CO)

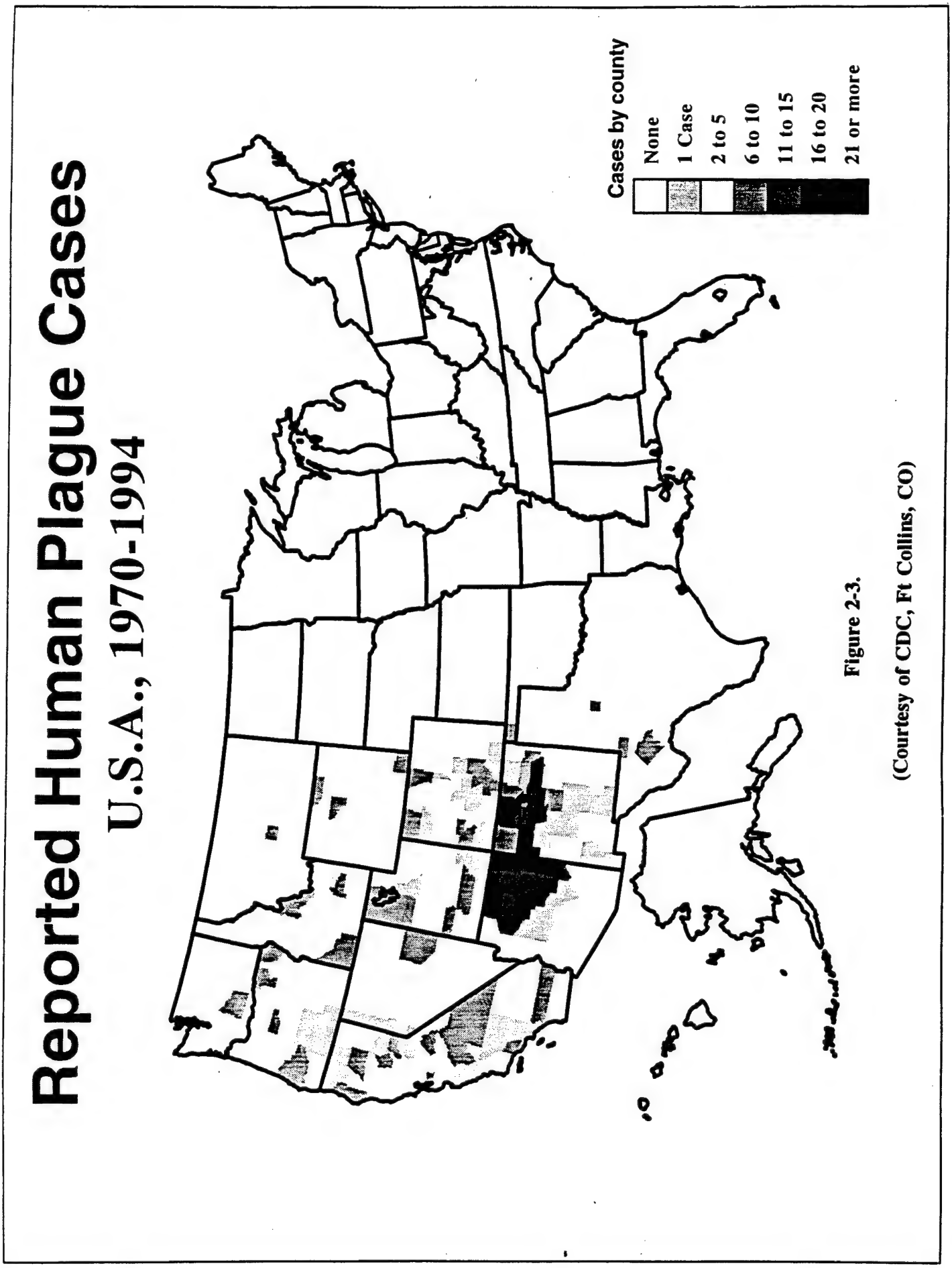

Figure 2-3.

(Courtesy of CDC, Ft Collins, CO)

b. Human cases of plague in recent years have occurred in Wyoming, New Mexico, California, Colorado, Arizona, Utah, Texas, Oklahoma, Nevada, Idaho, Montana, Washington and Oregon. New Mexico has had the highest number of cases reported. Plague has also been isolated from animals in these states and in Kansas, North Dakota, South Dakota, and Nebraska.

2-3. Incidence

a. Since 1965, the number of human plague cases in the United States has greatly increased. Within the past 25 years, more cases have been reported than in the previous 50 years. For the past 10 years, reported cases of plague in the United States have been less than 0.01 per 100,000 persons. Thirty-one cases were reported in 1984 due to prairie dog and rock squirrel epizootics, but there have been less than 15 reported cases a year since that time. Cases occur sporadically throughout the year; however, most occur between May and September, especially in July.

b. In the past, plague was a disease associated with unsanitary and close living conditions. Recently, plague has become associated with an increase in outdoor recreation and the encroachment of urban/suburban growth into previously wild areas. Most infections occur within a one-mile radius of the home, and most of those infected are younger than 20 years of age.

2-4. Clinical forms

Plague is caused by a bacterium, *Yersinia pestis*; in humans, this disease is expressed in three clinical forms: bubonic, septicemic, or pneumonic plague.

a. Bubonic plague. The term bubonic plague describes the plague bacteria's invasion of the lymph system. Infection can result from an infected flea bite. The lymph node, which drains the infected site, eventually becomes infected, and swelling and necrosis occur. The swollen lymph node, which may grow to the size of an orange, is called a bubo, hence the term bubonic plague. The incubation period is usually 2-6 days but may be shorter (as little as 36 hours) or longer (up to 10 days). The symptoms are usually abrupt with high fever, chills, headache, rapid heart beat, mental and physical exhaustion, and a very tender bubo. Occasionally, buboes cannot be detected for a day or so after the onset of their symptom. The disease progresses rapidly and may invade the blood stream, producing severe illness, called plague septicemia.

b. Septicemic plague. Septicemic plague occurs when the bacteria spread from the lymph system into the blood system. The liver and spleen attempt to filter out the bacteria from the

blood, but the bacteria multiply so fast that these organs are unable to efficiently filter out the bacteria. Consequently, the bacteria then invade the blood system with the bacterial antigens acting as toxins in the blood. The central nervous system and other lymph nodes may also become involved. The symptoms occur suddenly and include lethargy, mental confusion, agitation, collapse of peripheral capillaries, and possibly severe seizures, shock, delirium, and coma. Although unusual, plague bacteria may directly invade the blood system following a flea bite, thus bypassing the usual route of infection through the lymph system.

c. Pneumonic plague. Pneumonic plague may be either a secondary infection from the bubonic form or a primary infection from the inhalation of infective droplets from another individual (or animal) with pneumonic plague. The incubation is usually within 1-3 days. Symptoms are somewhat similar to other forms of severe pneumonia and include lung congestion, difficulty in breathing, high fever, pain in the chest, and a cough with frothing, bloody sputum loaded with plague bacteria.

2-5. About diagnosis, treatment, and immunization

a. Diagnosis. Diagnosis of human plague is confirmed by bacteriological or serological tests. Fluid from buboes, blood, spinal fluid or sputum may be used for testing. Laboratory animals may also be inoculated and necropsied. Obtaining diagnostic laboratory specimens should be done following the recommendations of the Centers for Disease Control (CDC) and Prevention. Physicians can obtain specific information by calling the CDC Division of Vector-Borne Infectious Disease, National Center for Infectious Disease, telephone (303) 221-6453.

b. Treatment. When untreated, bubonic plague has a fatality rate between 25-60 percent; septicemic and pneumonic plague are usually fatal if untreated (95-98 percent). If treatment is initiated within the first 15 to 24 hours after onset of symptoms, the prognosis is good even with septicemic and pneumonic plague. Unfortunately, incorrect diagnosis often results in inappropriate or delayed treatment, which may result in the death of the patient. A copy of the Plague Case Investigation Report (CDC Form 56.73) is provided in Figure 2-4 to assit medical personnel who are involved in treating human plague cases.

c. Immunization. Plague vaccine is available as an inactivated bacterial vaccine. It is given as a series of three doses with boosters given at six months to one year intervals if the risk of exposure persists. Reactions may include mild pain, erythema, and induration at the injection site. Immunization is recommended for persons working with *Yersinia pestis* in the laboratory or field and persons working with animals or visiting for prolonged periods in plague infested areas where they have little control over their environment, particularly in developing countries.

DEPARTMENT OF HEALTH & HUMAN SERVICES
PUBLIC HEALTH SERVICE
CENTERS FOR DISEASE CONTROL
P.O. BOX 2087
FT. COLLINS, CO 80522-2087

PLAGUE CASE INVESTIGATION REPORT

Date of Report: Mo. ☐☐ Day ☐☐ Year ☐☐

PATIENT IDENTIFICATION

Name (last, first, M.I.) | Telephone No. (Area Code) _____ _____

Address | City | State | County

AGE ☐☐ | SEX: 1 ☐ Male 2 ☐ Female | RACE: 1 ☐ White (not Hispanic) 2 ☐ Black (not Hispanic) 3 ☐ Hispanic 4 ☐ Asian or Pacific Islander 5 ☐ Amer. Indian or Alaskan 6 ☐ Unspecified | Date Hospitalized Mo. ☐☐ Day ☐☐ Yr. ☐☐

Person making call | Person taking call

Agency | Agency

Telephone (Area Code) _____ _____ | Telephone (Area Code) _____ _____

Has local health department been notified? ☐ Yes ☐ No If Yes, give name and address of person contacted.

Physician(s) _____ Telephone(s) (Area Code) _____

City _____ Hospital _____ Telephone (Area Code) _____

ILLNESS

Date of Onset of Illness Mo. ☐☐ Day ☐☐ Yr. ☐☐ Symptoms: _____

Signs

Temperature _____ R _____ BP _____ P _____ Date Mo. ☐☐ Day ☐☐ Yr. ☐☐

Bubo Inguinal ☐ Femoral ☐ Other ☐ Size (cm) Describe _____
Cervical ☐ Axillary ☐ —R ☐ —L ☐ Tender ☐ Yes ☐ No Erythema ☐ Yes ☐ No

Skin Ulcer ☐ Yes ☐ No Location _____ Insect Bite(s) ☐ Yes ☐ No Location _____

Cough? ☐ Yes ☐ No Date of Onset of Cough Mo. ☐☐ Day ☐☐ Yr. ☐☐ Cough productive? ☐ Yes ☐ No

Current condition and prognosis: _____

Outcome: Survived ☐ Discharge date Mo. ☐☐ Day ☐☐ Yr. ☐☐
Died ☐ Autopsy: ☐ Yes ☐ No (If yes, please attach autopsy report.)

PRIVACY ACT STATEMENT

The Centers for Disease Control, an Agency of the Department of Health and Human Services, is authorized to solicit this information under provisions of the Public Health Service Act, Section 301, (42 U.S.C. 241). Response in this case is voluntary, and there is no penalty for non response. The information requested is considered relevant and necessary to the investigation of health problems associated with plague. The individually-identified data requested may be shared with health departments and other public health or cooperating medical authorities. An accounting of such disclosures will be made available to the subject individual upon request.

Figure 2-4.

LABORATORY

Chest X-ray ☐ Yes ☐ No ☐ Unknown Pneumonia ☐ Yes ☐ No ☐ Unknown Date Mo. Day Yr.

WBC Count _____ Left Shift --- ☐ Yes -- ☐ No Bands _____ Polys _____ Lymph _____

Mono _____ Eos _____ Bas _____

Bacteria on blood smear? ☐ Yes ☐ No ☐ Don't know _____

Blood cultures taken? ☐ Yes ☐ No How many? _____ Results? _____

Bubo Aspirate: ☐ Yes ☐ No

Date Mo. Day Yr.

	POS.	NEG.
Gram Stain	☐	☐
Wayson Stain (or Wright's, Giemsa)	☐	☐
FA (Plague)	☐	☐
Culture	☐	☐

Sputum: ☐ Yes ☐ No

Date Mo. Day Yr.

	POS.	NEG.
Gram Stain	☐	☐
Wayson Stain (or Wright's, Giemsa)	☐	☐
FA (Plague)	☐	☐
Culture	☐	☐

Serologies:

S_1 result _____ Date(s) Serum Drawn Mo. Day Yr.

S_2 result _____

ANTIBIOTICS

Treatment	Date Started Mo.	Date Started Day	Date Stopped Mo.	Date Stopped Day	Dosage & Schedule
1 _____					1. _____
2 _____					2. _____
3 _____					3. _____

Isolation: ☐ Respiratory ☐ Wound precautions only ☐ None

EPIDEMIOLOGY

Whereabouts during 10 days before onset on (dates) (Include all outdoor activities):

Other persons ill after same exposure? Names and whereabouts:

Did patient handle sick or dead rodents, rabbits, or other animals? ☐ Yes ☐ No If so, where? _____

Patient recall flea or other insect bites? ☐ Yes ☐ No Contact with human plague patient? ☐ Yes ☐ No

Wild animal contact, including hunting? ☐ Yes ☐ No Contacts or relatives who died in past week? ☐ Yes ☐ No

Pets (kind and number) _____

Illness in pets? ☐ Yes ☐ No Describe: _____

Pets free roaming? ☐ Yes ☐ No ☐ Don't know

EPIDEMIOLOGY (Cont'd.)

Community Contacts During Illness Name*	Location and Time (Setting and Circumstances)	Date
a) Family and household:		
b) Work or school:		
c) Friends/acquaintances:		
d) Hospital:		

*When a group too large to list is involved, the location, setting, time and date will allow relevant persons to be traced (e.g., church, school, social activities, etc.)

To carry out field investigation in the home or work area, it would be helpful to get permission to enter and work on private property.

Who should be contacted for such permission? Name: _____ Telepnone No.: _____ _____
(Area Code)

2-6. The disease cycle

a. Transfer pattern. The transfer of plague bacteria from one host to another enables the bacteria to survive, multiply and spread. In areas where the bacteria, vectors, and reservoir hosts form an ecological association, the disease can circulate for indefinite periods. If the transfers of plague between hosts are examined over an extended period of time, a cyclical pattern of plague transfer can be identified. The determination of this cycle is the most important step in controlling the transmission of plague.

b. Types of cycles. The epidemiological cycle of plague is typically subdivided into human, urban (domestic), and rural (sylvatic) cycles (see Figure 2-5). Human (also called demic) plague cycles involve the transmission from human to human. Urban (also called domestic) plague cycles involve commensal rodents, usually the roof or Norway rat and the house mouse, and their associated fleas. Rural (also called sylvatic or campestral) plague cycles involve wild animals, usually rodents, and their associated fleas. Where human, urban, or rural host habitats overlap, there is a potential for plague to transfer from an infected group to a previously uninfected group, creating a plague cycle. For instance, there is a potential in the United States for a rural plague cycle to create an urban cycle, which in turn, could create a human cycle.

2-7. Modes of transmission

There are various means of plague transmission.

a. Flea bites. The bite of an infected flea is the most common means of plague transmission. Fleas can become infected when feeding on animals that have plague bacteria in their blood. When a flea becomes infected, the bacteria multiply in its proventriculus (crop) and stomach. The proventriculus has rows of spinelike teeth of variable length and number. Plague bacteria and an enzyme from the flea's stomach produce coagulase, which coagulates infected blood. The coagulated fibrin embeds plague bacteria and anchors them to the proventricular spines. As the bacteria multiply, a jelly-like mass of plague bacteria will eventually form an effective plug in the proventriculus so that blood cannot enter the stomach. Certain flea species are more susceptible to this proventricular blockage than others. Susceptibility depends on the amount of coagulant mixed with the ingested blood, the amount of enzyme secreted by the stomach of the flea, the number of bacteria ingested, flea temperature, and feeding frequency. When a flea feeds, the cibarial pump draws blood up into the pharynx. Large muscles attached to the pharynx then force the blood through the proventriculus into the stomach. When the proventriculus becomes blocked, the blood, which cannot pass beyond the block, becomes contaminated with plague bacteria. The contaminated blood is regurgitated into the host when the pumping muscles are relaxed. Fleas that become

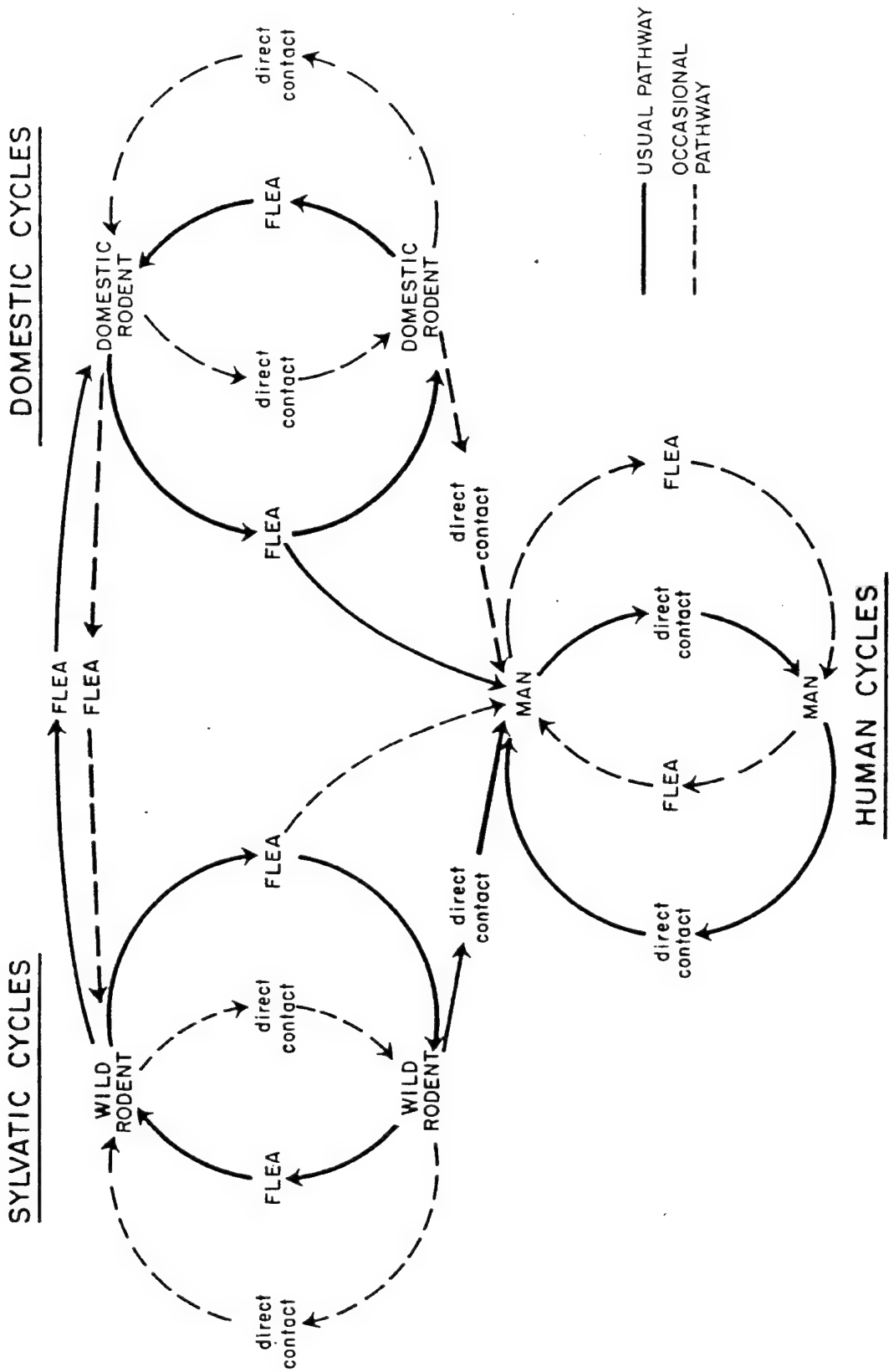

Figure 2-5. *The epidemiology of plague.*

blocked may continue to live for a lesser or greater period of time depending on the species involved and local climatic conditions. Keep in mind, however, that blocked fleas make repeated attempts to feed. Experiments have shown that only a very small percentage of unblocked infected fleas can transmit plague.

b. Flea feces. Live plague bacteria may also be found in flea feces. The bacteria can survive for weeks in dry flea feces. Plague infection could result from scratching infected feces into a flea bite wound. Crushing fleas with the teeth can infect the lining of the mouth.

c. Direct contact. Direct contact with a plague infected animal is another common method of plague transmission. During the winter months, most human plague cases are the result of hunters coming into direct contact with infected animals, usually rabbits. Infected blood or other body fluids can enter through wounds on the victim's skin; infected sputum can enter through the bite of an infected mammal; or eating infected animal tissue can infect the lining of the mouth.

d. Inhalation of droplets. The most dangerous form of plague transmission occurs when the disease is in the pneumonic form and an infected person or animal coughs up droplets, transmitting the bacteria. One person with pneumonic plague can infect many people over a wide area. The inhalation of droplets will cause primary pneumonic plague in the victim. This newly infected victim can, in turn, infect many other people. Similarly, cats are highly susceptible to plague and can infect humans. In recent years, increasing numbers of cats have developed pneumonic plague. Several human deaths have occurred from pneumonic plague following exposure to infected cats.

2-8. Reservoirs

Little is known about how plague is maintained in the environment. Different ecosystems may each have their own type of maintenance. Reservoir host species may be one means of maintenance. Plague susceptibility in individuals within a species, or in individual species within a community, may vary. Results of infection may range from no symptoms to 100 percent mortality. There are individual animals within populations that can carry live plague organisms in their blood for extended lengths of time without showing any ill effects. Other methods of plague maintenance include infected nest fleas which can survive away from their host for long periods of time; possible survival of plague bacteria in the soil of rodent burrows; or some overwintering mechanism in which the plague bacteria remain inactive in the rodent or flea until Spring. The maintenance of plague may be a combination of two or more of these mechanisms.

2-9. Fleas

Flea species differ greatly in their importance as vectors of plague (see Table 2-2). The ability of a flea species to transmit the bacteria to a host is one factor that determines the species' importance. There are also a number of ecological factors such as population densities, longevity, host specificity, physical parameters, feeding preference for plague reservoirs, habits, and movements that must be considered. Although some flea species are better vectors of plague than others, all flea species should be under suspicion as possible vectors.

Table 2-2. List of fleas found naturally infected with *Yersinia pestis* in the United States, 1975-1988 (from CDC Plague Section, Fort Collins, Colorado).

PULICIDAE

Cediopsylla inaequalis
* *Echidnophaga gallinacea*
* *Euhoplopsyllus glacialis affinis*
* *Hoplopsyllus anomalus*
* *Pulex simulans*

LEPTOPSYLLIDAE

Peromyscopsyla hesperomys
** *Odontopsyllus dentatus*

HYSTRICHOPSYLLIDAE

Anomiopsyllus sp.
Atyphloceras echis
Atyphloceras multidentatus
Catallagia decipiens
Catallagia sculleni
Epitedia stanfordi
Hystrichopsylla dippiei
** *Megarthroglossus* sp.
Meringis sp.
Meringis parkeri
Neopsylla alpina
** *Phalacropsylla allos*
Phalacropsylla paradisea
Rhadinopsylla sectilis
Rhadinopsylla fraterna
Stenistomera alpina

CERATOPHYLLIDAE

Aetheca wagneri
* *Ceratophyllus celsus*
Ceratophyllus ciliatus
* *Diamanus montanus*
* *Eumolpianus eumolpi*
Eumolpianus eutamiadis
Foxella ignota
Malareaus sinomus
Malareaus telchinus
* *Opisochrostis hirsutus*
* *Opisochrostis tuberculatus cynomuris*
Opisochrostis tuberculatus tuberculatus
Orchopeas leucopus
Orchopeas neotomae
Orchopeas sexdentatus
* *Oropsylla idahoensis*
* *Oropsylla labis*
Oxypsylla keeni
* *Thrassis bacchi bacchi*
Thrassis bacchi caducus
* *Thrassis bacchi consimilis*
Thrassis bacchi gladiolus
Thrassis bacchi pansus
Thrassis fotus
Pleochaetis exilis

* Proven to bite humans
** Naturally infected in a pooled inoculation with other flea species

a. The Oriental rat flea (*Xenopsylla cheopsis*) is an important vector of urban plague because its proventriculus tends to block rapidly, it is able to feed on both infected rodents and man, and it is abundant near human habitations in association with urban rats.

b. Diamanus montanus, the most common flea on rock squirrels and California ground squirrels, is an important vector of rural plague. It is very abundant, an efficient vector, and readily feeds on man. Its primary hosts are highly susceptible to plague and are often found in close association with humans.

2-10. Hosts

The various mammal species respond differently to plague infection and may have different roles in plague epizootics and human infection.

a. Role of resistant species. Some species, including several kangaroo rats and most carnivores (excluding cats), are resistant to plague. These animals may, however, mechanically transmit plague-infected fleas. For example, domestic dogs may transport infected fleas from the wild into the home. All rodents should be considered possible hosts of plague. Plague infected fleas have even been collected from burrowing owls. These owls may transfer plague from one ecosystem to another. Table 2-3 lists mammals found naturally infected with plague in the United States.

b. Role of partially resistant species. Some mammals, such as deer mice and Belding's and Townsend's ground squirrels, may be partially resistant to plague infection. These species may serve as reservoirs of plague as discussed above.

c. Role of susceptible species. Some mammal species are susceptible to plague but are only occasionally infected. Their infections probably originate with plague epizootics in other rodents. These species may serve as occasional sources of human infection. For example, chipmunks may become infected and transmit the disease to campers. Tree squirrels that have been introduced to urban areas usually do not contract plague, but they are susceptible and are potentially important. Cottontail rabbits are not known to be reservoirs of plague or to have epizootics. However, a number of human cases of plague every year are associated with handling, skinning, or eating plague-infected rabbits, or possibly from being bitten by their fleas. Domestic cats often react severely to plague infection, and humans may acquire the disease by contact with infected cats either through fluid from lesions, oral and respiratory infections, or from fleas.

Table 2-3. Taxonomic List of Mammals Found Naturally Infected with *Yersinia pestis* in the United States, 1900-1989 (CDC, Fort Collins, Colorado).

SCIENTIFIC NAME	COMMON NAME
ORDER INSECTIVORA - Insectivores	
FAMILY TALPIDAE	Moles
Scapanus latimanus	Broad-foot Mole
ORDER LAGOMORPHA	Hares, Rabbits and Pikas
FAMILY LEPORIDAE	Rabbits and Hares
Lepus americanus	Snowshoe Rabbit
Lepus californicus	Black-tailed Jack Rabbit
Lepus townsendi	White-tailed Jack Rabbit
Sylvilagus auduboni	Desert Cottontail
Sylvilagus bachmanni	Brush Rabbit
Sylvilagus nuttallii	Nuttall's Cottontail
ORDER RODENTIA	Rodents
FAMILY SCIURIDAE	Squirrels and Relatives
Tamias amoenus	Yellowpine Chipmunk
Tamias dorsalis	Cliff Chipmunk
Tamias merriami	Merriam's Chipmunk
Tamias minimus	Least Chipmunk
Tamias quadrimaculatus	Long-eared Chipmunk
Tamias quadrivitattus	Colorado Chipmunk
Tamias speciosus	Lodgepole Chipmunk
Tamias townsendi	Townsend's Chipmunk
Tamias umbrinus	Uinta Chipmunk
Marmota flaviventris	Yellow-bellied Marmot
Ammospermophilus leucurus	White-tailed Antelope Ground Squirrel
Spermophilus armatus	Uinta Ground Squirrel
Spermophilus beecheyi	California Ground Squirrel
Spermophilus beldingi	Belding's Ground Squirrel
Spermophilus columbianus	Columbian Ground Squirrel
Spermophilus lateralis	Golden-mantled Ground Squirrel
Spermophilus oregonus	(probably *S. beldingi oregonus*)
Spermophilus richardsoni	Richardson's Ground Squirrel
Spermophilus spilosoma	Spotted Ground Squirrel
Spermophilus townsendi	Townsend's Ground Squirrel
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel

SCIENTIFIC NAME	COMMON NAME
Spermophilus variegatus	Rock Squirrel
Spermophilus washingtoni	Washington's Ground Squirrel
Cynomys gunnisoni	Gunnison's Prairie Dog
Cynomys leucerus	White-tailed Prairie Dog
Cynomys ludovicianus	Black-tailed Prairie Dog
Cynomys parvidens	Utah Prairie Dog
Scirus aberti	Abert's Tassel-eared Squirrel
Scirus niger	Fox Squirrel
Tamiasciurus hudsonicus	Red Squirrel
Tamiasciurus douglasii	Douglas' Squirrel
Glaucomys sabrinus	Northern Flying Squirrel
FAMILY GEROMYIDAE	Pocket Gophers
Thomomys bottae	Botte's Southern Pocket Gopher
Thomomys talpoides	Northern Pocket Gopher
FAMILY HETEROMYIDAE	Pocket Mice and Kangaroo Rats
Dipodomys ordii	Ord's Kangaroo Rat
FAMILY CRICETIDAE	
Reithrodontomys megalotis	Western Harvest Mouse
Onychomys leucogaster	Northern Grasshopper Mouse
Onochomys torridus	Southern Grasshopper Mouse
Sigmodon hispidus	Hispid Cotton Rat
Neotoma albigula	White-throated Wood Rat
Neotoma cinerea	Bushy-tailed Wood Rat
Neotoma floridana	Eastern Wood Rat
Neotoma fuscipes	Dusky-footed Wood Rat
Neotoma lepida	Desert Wood Rat
Neotoma mexicana	Mexican Wood Rat
Neotoma micropus	Southern Plains Wood Rat
Neotoma stephensi	Stephen's Wood Rat
Microtus montanus	Montane Vole
Microtus californicus	California Vole
Microtus longicaudus	Long-tailed Vole
Microtus ochrogaster	Prairie Vole
Lagurus curtatus	Sagebrush Vole
Peromyscus boyleii	Brush Mouse
Peromyscus californicus	California Mouse

SCIENTIFIC NAME	COMMON NAME
Peromyscus crinitus	Canyon Mouse
Peromyscus difficilis	Rock Mouse
Peromyscus leucopus	White-footed Mouse
Peromyscus maniculatus	Deer Mouse
Peromyscus truei	Pinon Mouse
FAMILY MURIDAE	Old World Rats and Mice
Rattus norvegicus	Norway Rat
Rattus rattus	Roof Rat
Mus musculus	House Mouse
FAMILY ZAPODIDAE	Jumping Mice
Zapus princeps	Western Jumping Mouse
ORDER CARNIVORA - Carnivores	
FAMILY CANIDAE	Dogs, Wolves, Coyotes, and Foxes
Canis familiaris	Domestic Dog
Canis laterans	Coyote
Vulpes macrotis	Kit Fox
Vulpes velox	Swift Fox
Vulpes vulpes	Red Fox
Urocyon cinereoargenteus	Gray Fox
FAMILY URSIDAE	Bears
Ursus americanus	Black Bear
FAMILIY PROCYONIDAE	Racoon and Allies
Bassariscus astutus	Ringtail
Procyon lotor	Racoon
FAMILY MUSTELIDAE	Weasels, Martens, Wolverines, and Skunks
Martes americana	Marten
Mustela frenata	Long-tailed Weasel
Taxida taxa	Badger
Spilogale gracilis	Western Spotted Skunk
Mephistis mephistis	Striped Skunk

SCIENTIFIC NAME	COMMON NAME
FAMILY FELIDAE	Cats
Felis concolor	Mountain Lion
Felis catus	Domestic Cat
Lynx rufus	Bobcat
ORDER ARTIODACTYLA	
FAMILY SUIDAE	Pigs
Sus scrofa	Domestic Pig
FAMILY CERVIDA	
Antilocapra americana	Pronghorn Antelope
Odocoileus hemionus	Mule Deer

d. Role of highly susceptible species. Other rodent species are highly susceptible to plague. Table 2-4 lists host-flea complexes by geographic region, found to be involved in epizootic plague amplification in western North America. While a variety of chipmunks, ground squirrels, and wood rats have been involved in amplification of plague, the most widespread plague epizootics occur in prairie dogs, rock squirrels, and California ground squirrels. The disease has killed entire colonies of these latter three rodents. These rodents are often dead-end hosts of plague. However, rock squirrels and California ground squirrels may serve as reservoirs if the squirrel populations are widespread or their fleas abundant. Prairie dogs may transmit plague to humans through direct contact. Although the fleas on prairie dogs can transmit plague within the rodent colony, they rarely bite man, thereby reducing transmission of flea-borne plague. On the other hand, plague can be transmitted from rock squirrels and California ground squirrels to humans through direct contact or by the fleas. Infected, hungry squirrel fleas can often be found around dead rodents and their burrows and readily bite man.

Table 2-4. Host-flea complexes found involved in epizootic plague amplification in western North America, by geographic region (modified from Barnes, 1982).

State and Regions	Rodent Species	Flea Vectors
AZ, NM, southern CO, southern UT	*Spermophilus variegatus* (Rock Squirrel)	*Diamanus montanus*, *Hoplopsyllus anomalus*
AZ, NM, CO, UT (Rocky Mts and west)	*Cynomys gunnisoni* (Gunnison's Prairie Dog)	*Opisochrostis hirsutus*, *O. tuberculatus cynomuris*
CO (east of Rocky Mts), western TX, OK, KS	*C. ludovicianus* (Black-tailed Prairie Dog)	*O. hirsutus*, *O. t. cynomuris*
WY, northwestern CO, northeastern UT (high plains)	*C. leucurus* (White-tailed Prairie Dog)	*O. t. cynomuris*, *O. hirsutus*
CO, ID, MT, WY, (Mt parks, high plains, grassland)	*S. richardsoni* (Richardson's Ground Squirrel)	*Oropsylla labis*, *O. idahoensis* (Rocky Mts), *Thrassis bacchi*, *O. t. tuberculatus*
CA, OR, northern NV, southeastern ID (montane meadows, Great Basin sagebrush-grasslands)	*S. beldingi* (Belding's Ground Squirrel)	*T. frandisi*, *O. t. tubersulatus*, *T. petiolata*, *T. pandorae*
Southern ID, eastern OR, NV, UT (Great Basin sagebrush)	*S. townsendi* (Townsend's Ground Squirrel)	*T. francisi*
ID, UT, WY (Great Basin and montane 4000-8000 ft)	*S. armatus* (Uinta Ground Squirrel)	*T. pandorae* *O. francisi*

State and Regions	Rodent Species	Flea Vectors
CA, OR, western NV (valleys, foothill savannah, open pine forest to temperate rain forest edge)	*S. beecheyi* (California Ground Squirrel)	*D. montanus* *H. anomalus*
AZ, CA, CO, ID, MT, NV, NM, OR (montane areas, open pine forest)	*S. lateralis* (Golden-mantled Ground Squirrel)	*O. idahoensis* *O. (D.) montana* (Sierra-Cascade), *O. labis* (Rocky Mts)
Western U.S. from Rocky Mts westward	*Tamias* spp.* 16 species (chipmunks)	*Eumolpianus eumolpi* *E. eutamiadis,* *E. fornacis,* *Ceratophyllus ciliatus* (last 3 from Pacific states only)
Western U.S. from TX to the Pacific states (desert to high montane shrubby habitats)	*Neotoma* spp.** 8 species (wood rats)	*Orchopeas sexdentatus,* *O. neotomae,* *Anomiopsyllus* spp.
CO, WY, CA (urban residential and rural environments)	*Sciurus niger**** (Eastern Fox Squirrel)	*O. howardi*

* Individuals of nine species were found to have been plague-infected or carried plague-positive fleas

** Individuals of five species were found to have been plague-infected or carried plague-positive fleas

*** This periodomestic species has been introduced to western cities as a park squirrel along with its flea, *O. howardi*

CHAPTER 3

ARMY PLAGUE SURVEILLANCE PROGRAM

3-1. Overview

Plague surveillance is an important aspect of plague prevention and control. The presence or increased activity of plague in rodent populations often is not discovered until a human case occurs. Often, a diagnosis of human plague is not considered until after the patient recovers or dies. A good surveillance program will detect and provide early warning of plague activity. Surveillance allows physicians to prepare and confront the disease before it escalates to a severe human threat. Surveillance also provides information that gives insight into the maintenance and transmission cycles of the disease. Plague surveillance programs vary in different areas depending on public awareness, the status of plague activity, or the funds available.

3-2. Elements of the Army plague surveillance program

There are five major elements to the Army's plague surveillance program: rodent and flea population characterization, rodent population observation, carnivore blood serum collection and analysis, liaison with local, state, and Federal Health Departments (or other agencies), and epizootic investigation.

a. Rodent and flea population characterization.

(1) *Purpose.* This program element provides baseline data on the rodent and flea species at each installation surveyed, their distribution, relative population densities, host-parasite relationships, and seasonality. This information can be used to determine areas of potential plague epizootics and the potential for human involvement. The results also provide reference data to evaluate population changes that may indicate the occurrence of a plague epizootic. Such information would be valuable in an epizootic investigation or control program.

(2) *Method.* To characterize the rodent and flea population, the live trapping of rodents and collecting their fleas is conducted once in the spring, summer, and fall in each major habitat type at every installation. Trapping of each major habitat consists of a transect with a prescribed number of trap sites at specified intervals. (Appendix A details procedures for live trapping.) Each site is trapped for 3 consecutive days. Fleas are collected by brushing the anesthetized rodents. All rodents and fleas are identified to species.

b. Rodent population observation. This program element involves semi-monthly monitoring of highly plague-susceptible rodent colonies (prairie dogs, rock squirrels and California ground squirrels). Such monitoring notes any unusual conditions such as bad odors; sick, sluggish or dead animals; presence of carrion feeding flies; or vacant burrows that may signal plague activity. Rodent colony monitoring is initiated at the first sign of seasonal rodent activity and is discontinued when the colonies are dormant.

c. Carnivore blood serum collection.

(1) *Purpose.* This program element helps to identify plague activity, the level of activity, and its general location. When a plague epizootic occurs among susceptible rodents, dead and dying rodents are eaten by carnivores. The carnivores may then become infected either by rodent fleas or by direct contact with rodent tissue. Carnivores do not usually die from plague, but they do produce plague antibodies that are detectable using serological techniques. Testing the serum from one carnivore may be comparable to sampling several hundred rodents over a wide area. High antibody levels and a high proportion of serologically positive carnivores indicate more recent and widespread plague activity. A moderately large percentage (25-30 percent) of positive sera with relatively high titers (1:256 or greater) should be cause for concern.

(2) *Method.* Serum collection consists of trapping 25-30 carnivores from February through April each year at each selected installation. Blood serum or blood impregnated paper samples are sent to the CDC, Fort Collins, Colorado for antibody testing. See Appendix B for a more detailed discussion of carnivore serologies.

d. Liaison. This program element directs installation personnel to periodically contact local and state health authorities. Liaison keeps the installation personnel aware of the current and historical activity of plague in surrounding areas. If plague activity is discovered or shows an increase in nearby areas, surveillance or preventive measures can be increased or initiated on the installation. Results of Army surveillance are also very useful to civilian health authorities.

e. Epizootic investigation. Data from colony inspections, carnivore serologies or liaison may indicate the need for this element of the Army's surveillance program. Such an investigation should include, as a minimum, the collection of dead animals, trapping rodents for tissue, sera or flea collections; and swabbing burrows for fleas. Samples would be sent to the CDC for plague isolation. This information, along with the baseline data from the rodent and flea characterization element, would be used to verify the existence of plague; and to determine the geographical extent of the disease, the major habitats involved, the rodent and flea species involved, and the degree of potential human contact. The results would determine what preventive measures should be initiated.

CHAPTER 4

INSTALLATION PLAGUE SURVEILLANCE PROGRAM

4-1. Overview

a. In a plague endemic area, a plague surveillance program will provide a possible means for predicting and detecting plague epizootics. Such a surveillance program will provide sufficient time to conduct an investigation to determine the extent of the plague epizootic and degree of potential human contact. The results of the investigation will determine the procedures required (i.e., area quarantine, ectoparasite control, rodent control, etc.) to reduce the plague threat to humans.

b. This chapter describes standardized plague surveillance procedures.

4-2. Program components

The components of an installation plague surveillance program include:

a. Annual collection of carnivore blood serum samples. (See paragraph 4-3.)

b. Development of species and population density baseline data on rodents and fleas potentially involved in plague transmission (characterization of flea and rodent populations). (See paragraph 4-4.) This phase of surveillance may have been completed by this Center. See Appendix C for summary data from those installations where characterizations have been prepared.

c. Annual mapping of plague-susceptible colonial rodent populations. (See paragraph 4-5.)

d. Semimonthly observations of plague-susceptible rodent populations (normally April through November) for unusual conditions (sick, sluggish, or dead animals, etc.) that may signal plague activity. (See paragraph 4-6.)

e. Establishment of liaison with local and State health authorities and other appropriate officials to ascertain information on potential plague activity in the proximal civilian areas. (See paragraph 4-7.)

f. Public education on plague. (See paragraph 4-8.)

4-3. Carnivore blood sampling

a. Obtaining blood serum samples.

(1) Obtain carnivore blood serum samples by live trapping 25 to 30 carnivores (coyote, bobcat, fox, raccoon, badger, feral house cats, etc.) annually from February through April and draw a blood sample from each. Trap carnivores from scattered locations where plague would create a potential threat to humans if it occurred in the rodent population. If the carnivores are sacrificed, such collections will not significantly influence the population adversely if taken over an area of 20,000 acres or more.

(2) Submit serum samples to: Plague Section, Centers for Disease Control and Prevention, P.O. Box 2087, Fort Collins, Colorado 80522, telephone (303) 221-6450. CDC will analyze each serum sample for plague titers and determine the significance of any titers relative to the potential for a plague epizootic occurring in rodent populations on or near the installation. Appendix B details carnivore serologies.

b. Generalities about sampling. Some generalities about carnivore blood sampling are:

(1) Do not make assumptions (or commit a budget) on a single titer.

(2) Do not commit a control program on the basis of positive carnivore serologies alone. Identify both the animals from which the carnivores acquired plague and their vector fleas, and determine the human risk before considering control actions.

4-4. Characterizing rodent and flea species involved in plague transmission

a. Obtaining baseline data.

(1) Obtain baseline data by live trapping small rodents (i.e., *Microtus*, *Peromyscus*, etc.) from various habitats in spring, summer and fall, preferably April, July and October, excluding prairie dogs, California ground squirrels, rock squirrels and other colonizing rodents. Establish ten live-trap stations in each major habitat type. During each season, set traps on 3 consecutive days.

NOTE: Sin Nombre virus and other hantaviruses have been found in rodents, particularly *Peromyscus* spp. and *Microtus* spp., in many areas where plague is found. Adequate precautions must be taken during trapping and handling of rodents to reduce the chance of acquiring hantavirus infection. Recommendations for personal protective clothing and equipment can be obtained from the CDC, MEDCOM, or the USACHPPM.

(2) Anesthetize rodents with Metofane™ and comb them to remove the fleas. (Metofane is the anesthetic of choice. It should be ordered by the local veterinarian and must be used on his/her orders. The use of Metofane does not kill the plague organisms and is non-explosive; these are two factors that make the use of chloroform or ether unsatisfactory.) Identify rodents to species in the field when possible.

(3) Forward fleas to Commander, USACHPPM, DSA-W, ATTN: MCHB-AW-P, Fitzsimons Army Medical Center, Aurora, CO 80045-5001, for species identification. Record rodent collection data on CDC Form 56.32, Mammal-Ectoparasite Field Data (see Appendix A, paragraph A-9). An index of trapping success can be established based on captures per trap night.

(4) Appendix A provides specific procedures for capturing and processing small rodents and associated fleas from major habitats.

b. Determining population densities of the California ground squirrel and prairie dog.

(1) *Method.* Population densities of the California ground squirrel and prairie dog cannot readily be determined by trapping due to their colonizing nature. However, relative population densities can be determined with considerable accuracy by establishing 3 to 5-acre observation plots. Establish 2 observation plots for each 1,000 acres of infested grassland habitat having more than casual human contact. Use the same observation sites each year.

(a) Make counts on 3 consecutive days sometime between 1 May and 30 June, always at the same time each day, normally between 0800 and 1030 hours. Scan the plot from a well-chosen elevated vantage point using field glasses. Count visible rodents as the plot is scanned slowly back and forth until the entire plot has been covered. Scan each plot 3 times with 10-minute intervals between scans. Calculate the average number of rodents per scan per day.

(b) Thereafter, determine population densities (i.e., activity indices) annually using the above guidance.

(2) *Flea collection.*

(a) Live trap approximately 20 California ground squirrels and 20 prairie dogs each season (spring, summer, and fall) during the first year of surveillance and remove their fleas for species identification.

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(b) Annual trapping thereafter is not required. The appropriate medical authority will schedule subsequent trapping.

(3) *Considerations for trapping.*

(a) California ground squirrels. These animals can be trapped using collapsible live traps and rolled barley or oat bait. Process the squirrels and fleas as outlined in Appendix A, paragraphs A-6, A-7, A-8 and A-9.

(b) Prairie dogs. These animals are difficult to catch in collapsible live traps because they are usually not readily attracted to baits. Therefore, use single spring #1 steel traps placed in active burrows. Process prairie dogs and fleas as outlined in Appendix A, paragraphs A-6, A-7, A-8 and A-9.

c. Determining population densities of the rock squirrel.

(1) *Survey considerations.* Rock squirrel population density is difficult to determine because they tend to colonize in isolated pockets along cliffs, ravines, and rocky outcrops. Therefore, conduct surveys for their colonies in these varied habitats. In addition, since these squirrels are highly susceptible to plague, make efforts to locate all colonies in such terrain used for military training operations or recreational purposes.

(2) *Trapping.* Rock squirrels can be trapped, without difficulty, using collapsible live traps and rolled barley or oat bait. Live trap approximately 20 rock squirrels for each season (spring, summer, and fall). Annual trapping thereafter is not required. The appropriate medical authority will schedule subsequent trapping.

(3) *Processing.* Process rock squirrels and fleas as outlined in Appendix A, paragraphs A-6, A-7, A-8 and A-9. Rock squirrels can be identified to species in the field.

4-5. Mapping rodent colonies

Map annually the populations of colonial rodents commonly involved in plague transmission (prairie dogs, rock squirrels, and California ground squirrels). Draw these maps of colonies each spring, noting increases or decreases in previously existing colonies and additions of any new colonies.

4-6. Observing rodent activity

Semimonthly observations of prairie dog, California ground squirrel and rock squirrel populations for unusual conditions (sick, sluggish, dead animals, or other inactivity not attributable to seasonal changes) will provide data on potential plague epizootics. Observations may be temporarily discontinued during periods in which the rodents are normally inactive. This phase of the surveillance program requires the close scrutiny of personnel familiar with rodent activity. These personnel should--

a. Visit each colony on the installation every 2 weeks by driving through the colonies or observing them from a good vantage point (walking through rodent colonies, at least initially, may expose personnel to plague infected fleas if an epizootic or partial die-off has occurred).

b. Report unusual conditions to the Commander, USACHPPM, DSA-W, DSN 943-8090, to determine the need for initiating an epizootic investigation.

4-7. Establishing liaison

Periodically contact local and state health authorities for updates on the current and historical activity of plague in surrounding areas. If plague activity is discovered or shows an increase in nearby areas, surveillance or preventive measures can be increased or initiated.

4-8. Public education

a. Measured in terms of human infection and death, plague has never been a major public health problem in the United States. But it cannot be considered of minor importance, in terms of the potential dangers; the total cost of surveillance, prevention, and control; and the probability that it will never be eradicated from mammal populations. Public education plays an important role in the prevention and control of plague.

b. The local medical authority, through the public affairs office, should inform the public of the hazards of plague and the methods of avoiding it. In developing public education programs, the local medical authority should consider the following factors:

(1) *Target audience.* Direct public education programs especially towards individuals or groups who may have contact with wild rodents or are active outdoors through their work or recreation.

NOTE: Do not overlook the medical community when designing the education program. Medical personnel must be prepared to respond when plague is active in the area. Through the education program, medical personnel should be familiar with the various clinical forms of plague, aware of the importance of maintaining an appropriate level of clinical suspicion, and aware of the appropriate treatments.

(2) *Modes of communication.* Newspaper articles, information pamphlets, posters, and talks are all useful techniques for informing the public. (Appendix D contains a short talk about plague.)

(3) *Information content.* Information presented to the public should--

(a) Explain the manner of plague transmission, the importance of avoiding sick or dead rodents and their burrows, the importance of protecting pets from fleas with flea powder or collars, and the importance of seeing a physician if illness develops within a week of exposure to fleas or rodents.

(b) Request that people report unusual die-offs in rodent populations or rodent activity that might suggest the rodents are sick.

(c) Advise individuals whose work or other activities take them into potential plague areas to use personal protective measures, including the use of repellents (see Appendix E), to protect them from flea bites.

CHAPTER 5

PLAGUE EPIZOOTIC MANAGEMENT

5-1. Introduction

U.S. Army installations located in plague endemic areas should be prepared for plague epizootics. In the event of plague activity on or near Army installations, the U.S. Army Medical Command (MEDCOM) may request that this Center perform epizootic investigations and/or make recommendations for prevention and control of plague.

5-2. Plague prevention

In the event of suspected or confirmed plague activity, installation personnel should take immediate steps to reduce the human plague threat. Recommendations are as follows:

a. Contact MEDCOM for assistance in determining the need for an investigation. Assistance is available from this Center and may be obtained through appropriate channels. An investigation would include collecting dead and live animals, fleas from animals and their burrows, and carnivore blood samples. These samples would be sent to the CDC, Fort Collins, Colorado, to determine if plague bacteria or antibodies are present. The information would be used to verify the existence of plague and to determine the geographic extent of the disease, the major habitats involved, the rodent and flea species involved, and the degree of potential human contact.

b. Post confirmed or suspected plague outbreak areas off limits and restrict activity in the area to essential mission requirements. Inform personnel who must enter this area--

(1) Of the plague potential.

(2) To avoid sites with known highly plague susceptible rodent populations.

(3) To wear bloused pants, to use an insect repellent, and to not handle dead animals.

c. Control fleas in plague outbreak areas, if it is not practical to keep them off limits.

d. Inform medical personnel that plague is active in the area so that they may consider this disease when diagnosing fevers, swollen lymph nodes, and lung congestions.

e. Increase the public education program concerning plague.

f. Monitor closely squirrel (particularly rock squirrel and California ground squirrel), prairie dog, and/or rabbit populations.

g. Dispose of any infected carcasses that are not sent to CDC in such a way that pets or wild carnivores will not feed upon them (for example, bury 18-24 inches deep or incinerate). Ensure that personnel who dispose of carcasses take precautions to avoid infection. They should wear boots, gloves, long sleeved shirts and bloused pants; apply insect repellent; and use long-handled shovels to place mammals in plastic bags before transfer to the disposal site.

h. Prohibit hunting.

i. Encourage pet owners to control fleas on domestic pets and prevent pets from roaming loose.

j. Inform state and local health authorities of plague activity on the installation.

5-3. Plague epizootic investigation

Entomologists from the USACHPPM, DSA-West usually perform plague-epizootic investigations. However, an entomologist assigned to the installation medical authority or an individual with a good working knowledge of plague may perform the investigation as outlined below.

a. Coordination. The first step is to ensure that coordination exists between all activities and agencies concerned. Medical treatment, surveillance, rodent and/or flea control, education, and security are all important aspects of a plague prevention program. Contact appropriate personnel in the hospital, health clinic, Preventive Medicine Service (PVNTMED Svc), wildlife management, Public Works (may also be called Facilities Engineering), Veterinary Services, Military Police, and civilian agencies and present them with background information on the history and epidemiology of plague, an objective and factual description of the current plague activity and threat to humans, and a description of their role in the entire plague prevention program.

(1) *Hospital or health clinic staff.* Provide this staff with information on the characteristics and diagnosis of plague. This is important because most human plague cases can be cured if diagnosed early and plague treatment promptly applied.

(2) *PVNTMED Svc/health clinic personnel.* Provide them with information for the surveying of rodent colonies; collecting of rodents, carnivores, and fleas that will be used to indicate plague activity; applying insecticides; and determining insecticide effectiveness. Make PVNTMED Svc/health clinic personnel aware of the importance of promptly communicating their findings with other activities on the installation.

(3) *PVNTMED Svc personnel.*

(a) Provide them with information for educating installation personnel. Because it is not always possible to detect or to completely control plague in wild animals near areas of human activity, a public education program is one of the most effective methods of preventing human cases. Education programs should be directed primarily towards individuals or groups who may have contact with wild rodents or are active outdoors because of their employment or recreation. Newspaper articles, information pamphlets, posters, and talks are all useful techniques for informing people. Information should include the manner of plague transmission, the importance of avoiding sick or dead rodents and their burrows, the protection of pets from fleas, and the importance of seeing a physician if illness develops within a week of exposure.

(b) PVNTMED Svc personnel should work closely with the Public Affairs Office to ensure that newspaper articles contain factual and objective information so that the public is not unduly alarmed but is well informed. The PAO can also help with requests that the public report unusual die-offs in rodent populations to the PVNTMED Svc. Appendix D presents examples of information posters and a short talk. Pamphlets discussing plague prevention are usually available through state and local health departments.

(4) *Public Works pest control personnel.* Inform them that they may be required to control rodents and/or fleas in the event of plague activity or potential activity near areas of human activity. Review with them the preferred pesticides and where they may be obtained, the pesticide rates and application techniques and equipment, and how to interpret surveillance data. Chapter 6 presents more specific information on flea control.

(5) *Veterinary Service personnel.* Inform them that they may be able to collect carnivore serum, treat domestic pets for fleas, and help dispose of plague-infected carcasses. Make them aware that plague is active in the area and that dogs and cats may become infected. Also, ensure that they are aware that dogs do not usually die from plague, but the disease is often fatal to cats.

NOTE: Pets can pick up plague from infected wild animals and then transfer the disease (through fleas, scratches, bites, body fluids, coughing, etc.) to humans. Serologies from dogs and cats may be useful data.

(6) *Federal, state, and local health agencies.* Contact them immediately when plague activity is suspected on an installation. These agencies will be able to give the status of plague activity in the area, valuable information on plague control, and assistance in dealing with a plague outbreak. Also, the information that the Army provides will assist them in their plague-surveillance responsibilities. Appendix F lists state health department telephone numbers, and Appendix G lists state and Federal contacts for vector control information.

b. Scope of the investigation. The purpose of an investigation of an outbreak of plague in wild animals (epizootic investigation) is to determine the extent (level of activity and geographic range) of the outbreak; the areas that are near human activity which have, or may potentially have, plague activity; and the mammal and flea species that are involved, or may potentially be involved. The data collected during the rodent and flea characterization surveys previously conducted by this Center (Appendix C) will give a fairly accurate picture of what mammals, fleas, and habitat types are involved in the outbreak. This information will direct you to habitat types that should be suspected of having plague-infected rodents.

c. Priorities.

(1) First survey areas having the highest potential for human plague. This includes areas with populations of highly susceptible colonial rodents (for example, prairie dogs, rock squirrels or California ground squirrels) that are near areas of human activity.

(2) If possible, also survey those areas with a lower-plague potential. This includes populations of highly plague-susceptible colonial rodents near areas of low human activity or areas containing other plague susceptible rodents (for example, thirteen-lined, antelope or spotted ground squirrels; chipmunks; wood rats; or domestic rats or mice).

d. Defining plague activity. Use one or more of the methods described below to define plague activity.

(1) *Visual survey.* Locations that have a human-plague potential require a very thorough, visual survey. Signs that indicate plague activity include sluggish or dead rodents, vacant burrows, blow flies or rotting smells near burrows, or the absence of rodents that are normally sighted in the area. On the other hand, high populations of plague-susceptible rodents may indicate a potential outbreak area.

(2) *"Inclusive" survey.* More inclusive surveys include the collection of blood, tissue and/or fleas from rodents, carnivores and burrows. Collect fleas from rodents and rodent burrows, and send them to CDC as described in Appendix A. Trap small carnivores (for example, skunks, badgers, ringtails, weasels) in each general area (which may include more than one survey site) and send blood samples to CDC as described in Appendix B.

(3) *Other determining factors.* In addition to visual survey results, the following findings can be used to determine if plague is active in an area.

(a) If plague is found in a high percentage of flea pools, plague activity can be considered great, and if positive flea pools are found in many areas, the outbreak can be considered widespread. The species of fleas and the sources of the fleas may also indicate what rodents are most involved in the outbreak.

(b) If flea species that normally seem to prefer a certain rodent species are found in large numbers on rodent species that are not normally the preferred hosts, the normal host may be involved in a die-off.

(c) If the relative distribution of rodent species is significantly altered (for example, in the rodent-flea characterization, rock squirrels accounted for 50 percent of the total population; at the time of the plague outbreak investigation, they make up only 5 percent), a die-off probably occurred in the area, providing sampling conditions (season, weather, habitat, etc.) are comparable.

(d) If carnivore serologies are positive for plague antibodies, plague has been and may still be active in the area. High antibody titers indicate more recent plague activity. If titers collected over a period of time are decreasing, plague activity may also be decreasing; if they are increasing, plague activity is increasing.

5-4. Plague control

To control plague, initiate the following measures--

a. Plot on a map all locations that have a potential for plague activity, and indicate the level of plague activity or the potential for activity.

b. Place all areas off limits that have plague activity or a high human-plague potential.

c. Treat areas near high human activity and populations of highly susceptible rodents with insecticide to control fleas. This will eliminate most of the plague-infected fleas where a die-off has occurred, and will help prevent plague from spreading into or through an area where plague-potential exists.

d. Monitor the areas near human activity that have susceptible colonial rodents at least weekly during the remainder of the most active plague season (May-September).

e. If appropriate, initiate food and harborage cleanup to make cantonment areas less desirable habitats to both wild and domestic rodents.

f. Control highly plague-susceptible wild rodents in cantonment areas, domestic rats, and mice.

g. Treat domestic pets for fleas and prohibit them from roaming.

h. Increase education of installation personnel.

CHAPTER 6

RODENT AND FLEA CONTROL

6-1. Introduction

Rodent and flea control programs may be initiated because of the detection of plague activity (especially in the area of a human plague case), because of an observation of a plague epizootic in areas of high human risk, or because an area has susceptible rodents, high human activity, and a history of plague activity in the area.

6-2. Rodent control

a. Urban outbreaks. The control of urban outbreaks in the early 1900s relied primarily on rodent control programs, which were very successful. Rat control programs in urban areas have developed considerably since then and have been important in reducing the hazards of urban epidemics in the United States. To control urban plague outbreaks, first apply insecticides in buildings, rat burrows, and rat harborages. This procedure, accompanied by rodent control with anticoagulant baits, gives the insecticides time to kill infective fleas before the rodent dies. In a few days apply acute, single dose rodenticides, set rat traps, rat proof buildings, and remove rat harborage and food.

b. Rural outbreaks. Wild rodent control has not been as successful as urban rat control. Widespread rodent control in rural areas is not very effective because it is difficult, expensive, time consuming, and often meets with public disapproval. However, the reduction or elimination of highly plague susceptible rodent populations in areas of high human activity may reduce the potential for human exposure to plague. To control rural outbreaks of plague, remove or destroy nesting areas, improve sanitation to eliminate food sources, or apply rodenticides.

c. Management of colonial animals.

(1) The best way to eliminate the plague potential in rural areas is to control the number of colonial animals (prairie dogs, rock squirrels and California ground squirrels) in areas of human use. Once these animals build up in large numbers, a plague epizootic results in the need for a flea control program. Thus, proper management of colonial animals reduces the chances of an epizootic and the resultant need for flea control.

(2) Management of field rodents permits sustained use of training areas since restrictions due to a plague epizootic have been minimized. Because field-rodent control is highly dependent on the species involved, geographic location (state), type of rodenticides available, environmental considerations (endangered species, nontarget animals, etc.), and resources (labor and material costs, and time), there is no concise strategy for control that can be implemented at all locations.

(3) Field-rodent control must be individually tailored to each installation. Information can usually be obtained from local, state and Federal vector control, animal damage control, and wildlife specialists. Appendix H lists the U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Animal Damage Control Western Region offices.

d. Role of flea control.

(1) Precede any rodent-control program in plague-enzootic areas with flea control. Otherwise, large numbers of infected fleas will be seeking new hosts, thereby increasing the potential for human infection.

(2) As an alternative to flea control, declare an area off limits until the numbers of live fleas are reduced to levels indicated in paragraph 6-3*d*. Since fleas remain alive for long periods of time in rodent burrows, it may be months before the land may be safe for human use.

6-3. Flea control

a. Significance. The bite of an infected flea is the predominant method for military personnel to acquire plague. The greatest potential for flea bites occurs in the vicinity of colonial-rodent burrows (prairie dogs, rock squirrels and California ground squirrels). Plague-infected fleas found on live rodents generally stay on the animals and pose little immediate threat unless the rodents are handled (healthy rodents normally avoid humans; however, sick rodents may permit close contact). When plague-infected rodents die, the infected fleas leave the body to look for new hosts. These fleas tend to congregate at the entrance to burrows and jump onto nearly any warm-blooded animal, including man, that passes by.

b. Flea-control methods. Prairie dog, rock squirrel and California ground squirrel fleas should be controlled in areas of high human activity when plague is known to be active in the area.

(1) To control prairie dog and California ground squirrel fleas, dust all burrows in the area with appropriate amounts of insecticide.

(2) It may be impractical to control rock squirrel fleas in the same manner because rock squirrel burrows are often located within heavy, tall ground cover. In such cases, use rodent bait stations containing insecticide. Place bait (i.e., oatmeal) in the center of the stations and appropriate amounts of insecticide dust in each end. Place the stations at 100 foot intervals. Commercially available, weather-resistant cardboard stations or 4-inch diameter, 30-inch long plastic cylinders may be used as bait stations.

c. Insecticide use.

(1) *Compounds.* In the past, 5.0 or 7.5 percent carbaryl dust has been used for burrow flea control. However, in recent years, some flea resistance to carbaryl, particularly in California, has been noted. Chlorpyrifos, propoxur, bendiocarb, and diazinon dusts are effective in reducing flea populations; however, this type of application may not be listed on the labels.

(2) *Application.* A local-use exemption is required before use of any insecticide if application to rodent burrows is not specified on the label. Apply these dusts at the rate of 2 ounces per burrow or bait station.

(3) *Insecticide of choice.* Permethrin is the insecticide of choice for flea control in burrows; however, this product is not registered for use in all states. Refer to the product label (Figure 6-1) for those states where this product has received a local needs registration. The label suggests an application rate of 1 to 2 ounces of dust per burrow, but effective flea control has been obtained in field studies using 1/4 to 1/2 ounce per burrow.

d. Flea surveys. Perform flea surveys 1-7 days before and 2-7 days after insecticide application to determine insecticide effectiveness.

(1) Perform flea surveys on prairie dog and California ground squirrel burrows when controlling fleas from these rodents, because the burrows are found predominately in open space. A burrow flea index (average number of fleas per burrow) of 0.3 or less indicates effective flea control.

(2) Perform flea surveys on captured rock squirrels when controlling their fleas because their burrows are difficult to find. A squirrel flea index (average number of fleas per squirrel) of 1.0 or less, indicates effective flea control. Re-treat areas if flea control has not been effective.

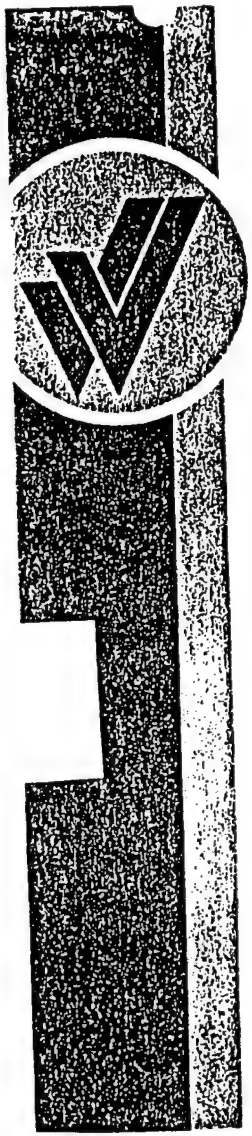
e. Special considerations -- rock squirrel plague epizootic. If a plague epizootic has killed most or all rock squirrels in an area, bait tubes may not be effective in reducing the plague threat to humans or domestic animals. If the area cannot be placed off limits, then individual burrow dusting may be necessary. Mark burrows that are found (this may be very time consuming) after dusting to enable survey personnel to evaluate the effectiveness of flea control procedures.

f. Burrow flea index. To determine the burrow flea index, swab 50 random burrows in each treatment area for fleas. Swab burrows by attaching a 1-square foot piece of flannel cloth (fuzzy side out) to the end of a 10-foot flexible cable (plumber's snake). Feed the cloth into the burrow 2 or more feet without excessive forcing or twisting. Extract the cloth slowly, place it in a plastic bag, and remove it from the cable. Freeze the sealed bags for 1 hour, and count the fleas.

g. Squirrel flea index. To determine the squirrel flea index, live trap 20-30 rock squirrels per area. Kill trapped rodents by placing them in a sealed container (i.e., plastic bag, gallon jar, or box) containing Metofane. Remove the dead squirrel. Using a stiff toothbrush, brush fleas remaining on the squirrel into a white enamel pan. Count the fleas remaining in the sealed container and those brushed off the squirrel. Bury dead squirrels 18-24 inches below the ground surface or dispose in such a way (i.e., incineration) that they will not be fed upon by pets or wild carnivores.

NOTE: Rock squirrels trapped in an area where plague is active should be killed even though they may appear healthy and have few, if any fleas. These animals may have active plague infections which are not readily observable at the time of capture. Although the threat of plague transmission from fleas may have been significantly reduced, plague may still be spread through the colony by direct contact between squirrels, and outside the colony by scavengers and carnivores which feed on the dying or dead animals.

h. Personal protective equipment. When involved in flea control or flea surveys, take the following precautions to avoid infection: wear boots, gloves, long-sleeved shirts and bloused pants, and apply insect repellent (see Appendix E for a list of standard repellents).



PYRAPERM™ 455 DUST

EPA SLN No.:
AZ-880023; CO-880009; ID-890077;
MT-890001; NV-880004; NM-880004;
OR-890077; TX-890005; UT-890077;
WY-890001.

EPA Est. No. 279-NY-1

* ***For use and distribution only within the states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah and Wyoming***
* ***In Montana, to be applied only by or under direction of Federal or State Vector Control or Public Health Pest Control personnel.***

ACTIVE INGREDIENTS:	
Pyrethrins	0.05%
*Piperonyl Butoxide, Technical	4.00%
†Permethrin	0.50%
INERT INGREDIENTS:	95.45%
	100.00%

*Equivalent to 3.2% (butylcarbityl) (6-propylpiperonyl) ether and 0.8% related compounds

†(3-phenoxyphenyl) methyl (+/-) *cis/trans* 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate (*cis/trans* ratio: min. 35% (+/-) *cis* and max. 65% (+/-) *trans*).

PYRAPERM - Trademark - Fairfield American Corporation

KEEP OUT OF REACH OF CHILDREN

CAUTION

See side panel for additional precautionary statements.

NET CONTENTS: 7 POUNDS
NET CONTENTS: 3.17 KILOS

120789 94400

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This labeling must be in the possession of the user at the time of pesticide application.

This product is for use only in insecticide-bait tubes or in direct application to rodent burrow openings for control of ***Fleas*** and other ***Ectoparasites*** associated with ground squirrels, tree squirrels, chipmunks, prairie dogs, and wild and domestic rats and mice.

Insecticide-Bait Tubes - Apply by placing 1 to 2 ounces of dust at each end of the tube. Leave the tube in place for a minimum of 3 weeks. Replace grain and replenish product as needed. In areas of high rodent populations, bait tubes can be left in place or moved about within treated areas for prolonged periods to ensure application to the greatest number of rodents.

Direct Application to Rodent Burrows - Apply 1 to 2 ounces of dust into rodent burrow openings by insufflation with hand or with pressurized duster. Reapply as needed at 10 to 12 week intervals.

STORAGE AND DISPOSAL

Do not contaminate food, feed or water by storage or disposal.

PESTICIDE STORAGE AND SPILL PROCEDURES: Store upright at room temperature. Keep away from moisture. Sweep up and dispose of with chemical waste.

PESTICIDE DISPOSAL: Pesticide, spray mixture or rinse water that cannot be used according to label instructions must be disposed of at or by an approved waste disposal facility.

CONTAINER DISPOSAL: Completely empty liner by shaking and tapping sides and bottom to loosen clinging particles. Empty residue into application equipment. Then dispose of liner in a sanitary landfill or by incineration if allowed by State and local authorities.

If drum is contaminated and cannot be reused, dispose of in same manner.

CONTAINERS ONE POUND AND SMALLER: Do not reuse container. Wrap container in several layers of newspaper and discard in trash.

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS CAUTION

Harmful if swallowed or absorbed through skin. Avoid inhalation, contact with skin, eyes or clothing. Wash thoroughly after handling.

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED: Call a physician or Poison Control Center. Do not induce vomiting unless directed by a physician. This product contains petroleum distillate. Aspiration may be a hazard.

IF INHALED: Remove affected person to fresh air. Apply artificial respiration if indicated.

IF ON SKIN: Remove contaminated clothing and wash affected areas with soap and water.

IF IN EYES: Flush eyes with plenty of water. Call a physician if irritation persists.

ENVIRONMENTAL HAZARDS

This product is extremely toxic to fish. Do not contaminate water by cleaning of equipment or disposal of wastes. Keep out of lakes, streams or ponds, tidal marshes or estuaries. Apply this product only as specified on this label.

Buyer assumes all risks of use, storage or handling of this material not in strict accordance with directions given herewith.

Fairfield American Corporation
201 Route 17 North, Rutherford, NJ 07070

Figure 6-1. *A sample label for Permethrin. The label lists those states where Permethrin may be permitted for use.*

APPENDIX A

SPECIFIC PROCEDURES FOR CAPTURING AND PROCESSING SMALL RODENTS AND ASSOCIATED FLEAS FROM MAJOR HABITATS

A-1. Trap site determination

Trap rodents from areas on the installation that represent different habitats. (The term habitat refers to an area that has similar plant life and physical features in which an animal or group of animals normally live.)

A-2. Trap site description

The trap site description will identify plant life and physical features where the trap line is located. USACHPPM, DSA-W will provide forms upon request to enable individuals to conveniently describe the trapping site. See Figure A-1 for a sample habitat description form.

A-3. Establishing traplines

Establish a trapline within each habitat to be sampled. The basic unit for the project consists of a straight line of 10 trap stations at 30-foot intervals. When accessibility, size, and shape of the habitat make one long transect impractical, alternative patterns may be used (for example, 2 lines consisting of 5 trap stations placed at 30-foot intervals). The distance between lines should be 30 feet. If the area to be trapped does not have any side (or boundary) that is at least 150 feet in length, then randomly disperse the trap stations within the trapping site with a distance of 30 feet between them. Each station consists of one 5 by 5 by 16-inch collapsible and two 3 by 3 by 10-inch rigid live traps. Obtain information on the types and sources of traps from this Center.

a. The basic trapline should transect those areas most representative of the habitat, (i.e., areas with rocks, grass, shrubs, trees, etc., should be included). Follow a straight line if possible.

b. In areas likely to contain a species that has specialized habitat requirements, set traps especially for that species. In this instance, use 20 appropriately sized traps. Set these traps

HABITAT FACTORS

Date_____

Installation_____

Observers_____

Grid Coordinates_____

Elevation_____ meters

GENERAL TOPOGRAPHY

__Plain (almost level)
__Rolling Hills (undulating)
__Mountains

LANDFORM

__Drainage
__Bottomland/Floodplain/Valley Floor
__Wetland

__Cove/Hollow
__Draw/Ravine
__Canyon
__Valley

__Terrace
__Alluvial Fan
__Hillside

__Ridge/Mountain Top
__Butte/Mesa

SLOPE **POSITION ON SLOPE**

__Level/Flat __Bottom
__Gentle __Middle
__Moderate __Top
__Steep

ASPECT (Direction Slope Faces)
(circle one)
N NE E SE S SW W NW

HUMAN ACTIVITY/INFLUENCE
__Low __Moderate __High

NEAREST AVAILABLE WATER

__River/Stream __Permanent
__Lake/Pond __Intermittent
__Marsh __Temporary
__Spring

SOIL

__Sand __Clay
__Gravel __Loam
__Rock __small __Wet
__large __Dry

VEGETATIVE TYPE

__Barren __Rangeland (grass/brush)
__Desert __Meadow/Savannah
__Scrub __Riparian (stream/marsh)
__Woodland/Forest

GROUND COVER (estimate percentage of each)

__Bare __Litter __Grass __Forbs

SHRUB DISPERSION **HEIGHT**

__Few __Low (<1m)
__Scattered __Medium (1-2m)
__Clumped __Tall (>2m)
__Large Blocks
__Solid Stand

TREE CANOPY **CANOPY CLOSURE**

__Deciduous __0-25%
__Conifer __26-50%
__Deciduous-Conifer mix __51-75%
__% Standing Dead Trees __>76%

Openings __Few __Some __Many

SPECIES DIVERSITY

	low	moderate	high
Birds	__	__	__
Mammals	__	__	__
Vegetation	__	__	__

Figure A-1. *Sample habitat description form.*

at random in specific areas most likely to catch the target species. Example: In most instances *Microtus* cannot be captured unless the traps are contiguous with the runway beneath grass cover.

c. Assign an alphanumeric code to each trapline. The first three letters will be the first three letters in the installation's name, for example ORD (Fort Ord), CAR (Fort Carson), ROB (Camp Roberts). The letter designation will be followed by the sequential number of each trapline as it is selected. Example: A meadow that is sampled with the basic trapline may be coded "CAR-01." If at the same time other traps are set under grass next to *Microtus* runways, this becomes a different "habitat" and must be coded differently; code "CAR-02" may be suitable.

d. Once a habitat has been selected for sampling, complete a habitat description form. Use the completed form for each 3-day period that the rodents are collected.

e. Mark the individual trap stations with brightly colored streamers, engineer survey tape or surveying flags on wire stakes. The traps should be within 5 feet of the marker. Number the streamers according to their position in the trapline. If the traps are subject to theft or vandalism, use alternative methods (less obvious) of identifying trap locations.

f. Traps should be shaded by logs, trees, shrubs, etc. To provide shade, place vegetation or even a precut board over the trap. Such cover will not alter trapping success and may prevent death of an animal by heat prostration. Trapping in hot, barren areas may force the trapper to carry covers made of canvas, wood or other material in order to shade the captured animals. Roofing paper (30 lb) is also good for making a cover that will shade a trap without touching it due to the tendency to retain the curved shape of the roll. Checking the traps early in the morning may reduce trap death. A dead animal in a trap has probably lost most of its fleas, which is a substantial portion of the desired data.

g. In cold areas, protection from snow, rain, wind, etc., is important. Careful placement of the traps or placement as described above for shading will afford protection. Wool or synthetic fiber quilt batting placed in the traps provides bedding material that provides warmth even when wet.

h. Operate trap stations for three consecutive 24-hour periods. Check traps and collect rodents twice each day before 0900 hours and again between 1600 and 1800 hours. Removal of trapped rodents along a trapline creates a "biological vacuum," and similar rodents from surrounding areas will quickly move in to fill it. A trapping program of this size will probably not affect the population.

A-4. Baiting and setting traps

a. Adjust traps prior to going into the field. Check the traps again while setting. To check collapsible live traps, set the trap and touch the treadle (the tripping mechanism) with a pencil or stick. The trap should snap with little pressure. To test the rigid live traps, set the trap, grasp the back end of it with one hand and gently slap the bottom of the trap with the heel of the other hand. The trap should snap at this time. Adjust the door retaining mechanism with pliers if required so that the traps will snap with little effort. Take care in adjusting the trap so that it does not snap upon being moved or picked up.

b. Place rolled oats bait in the rigid live traps through the trap doors. Bait may be placed in the traps at any time. Ensure that no bait has fallen under the treadle at the time of setting. Place traps at a slight incline so that bait will shift to the back and away from the treadle.

c. Bait collapsible live traps after they have been set at the trapping site. Sprinkle half a handful of the rolled oats behind the treadle. Sprinkle some bait in front of the treadle and around the entrance of the trap.

A-5. Collecting rodents

a. Pick up captured rodents at the appropriate times and label the trap with the date, the trap line number, and the sequential number of the rodent with respect to other captured rodents on the same date on the same trap line. Athletic adhesive tape is a suitable label; soft lead pencils should be used. Example: A label could read 920521CAR-02/07. The date is listed as year, month, day; the three letters designate the installation, in this case Fort Carson; the 02 refers to the second trapline; and, the 07 designates the seventh rodent captured on this date on this trapline.

b. Replace collected traps with spare baited traps.

c. It is imperative that traps from different habitats and traps of different sizes remain segregated at all times.

A-6. Processing rodents

a. Anesthetizing jar. To make the anesthetizing jar, wire a large cotton pad or a stack of 4 by 4 inch gauze pads to the lid of an appropriate size jar and soak the cotton or pads with

the pan and collect the fleas. To activate fleas and thus make them more obvious, blow gently into the pan. To simplify flea collection, dip the tip of an applicator stick into an alcohol vial (3 drops of glycerin have been added per quart of 95 percent ethyl alcohol) and touch the fleas that adhere to the stick. Dipping the stick into the alcohol will remove the specimens. Bury debris after it has been checked; do not try to reuse it as bait. (Fleas should remain in the enamel pan; however, this is not always possible. White terrycloth towels placed on the work surface under the jar and pan make escaped fleas more visible and easier to capture.)

NOTE: If fleas removed from rodents are to be used for plague isolation, place collected specimens in 2 percent saline solution in lieu of alcohol. (Normal saline solution may be substituted for the 2 percent saline.) Keep fleas in solution at room temperature while awaiting shipment for processing.

(2) When the rodent is fully anesthetized, remove and place it into the enamel pan. Check the anesthetizing jar and collect any fleas.

(3) Hold the rodent by the hind foot and brush vigorously from posterior to anterior so that brushed fleas fall into the pan. A tooth brush with only one row of bristles is a perfect combing tool. Bristles must be stiff and white. Collect fleas as described in paragraph A-6c(1) above.

(4) Identify the rodent to species, if possible, and enter the required data on CDC Form 56.32, Mammal-Ectoparasite Field Data. Guidance in execution of this form is provided in paragraph A-9, Recording data.

(5) Submit rodents that cannot be identified to species to USACHPPM, DSA-W. Make the following measurements [in millimeters (mm)] and record them prior to freezing:

(a) Total length.

(b) Length of tail.

(c) Length of hind foot.

(d) Length of ear from notch.

(e) Length of ear from crown.

NOTE: Record these measurements in the order specified above. **DO NOT** alter this sequence. Numbers must be separated by hyphens, and the last two measurements are preceded by e/n and e/c respectively, e.g., 170-78-22-e/n20-e/c12.

Metofane. A wide-mouth quart or gallon jar is usually adequate depending on the size of the rodents to be processed.

NOTE: Metofane may be extremely harmful if not used properly. Read the label for directions and precautions. Always use this product in a well-ventilated area.

b. Removing rodents from traps.

(1) *Rigid live traps.*

(a) Place the back end of the trap into a strong, clear, plastic bag and seal the mouth of the bag around the trap with both hands. With the thumbs, press on the top of the trap immediately in front of the back door flange and push the door open. With a short, quick throwing motion, throw the rodent and debris into the plastic bag.

(b) Remove the trap from the bag. Hold the mouth of the bag closed with one hand and with the other hand force the rodent toward the mouth of the bag. Grasping the bag behind the rodent will prevent introduction of bait into the anesthetizing jar. Force the rodent into the jar and quickly cover with the lid. A wide mouth quart or gallon jar is adequate.

(2) *Collapsible live traps.*

(a) Rodents captured in these traps will normally be larger, and thick gloves should be worn while handling them. Plastic bags used in removing these rodents from the trap may be doubled (one inside another) for strength. Cloth bags may also be used.

(b) Place the trap with the trap door down and force the rodent to go to the bottom. Unlock the back door and place the double bag over it. Seal the mouth around the trap with two hands. Orient the trap so that the door does not close on picking up the trap. Place the trap and the bag horizontally. If the rodent does not readily enter the bag, blow gently on the rodent from the back to make the animal move. In some instances, lowering the back of the trap results in the rodent running uphill into the bag. Place the mouth of the bag into the anesthetizing jar, force the rodent into the jar and cover quickly with the lid. A wide-mouth gallon jar is adequate. (When personnel handling trapped rodents gain experience, the bag may be omitted. Place the trap end directly against the gallon jar; blowing on the rodent often assists movement from the trap.)

c. Combing rodents.

(1) While waiting for the rodent to be anesthetized, dump the bag contents into a large white enamel pan at least 6 inches deep and check the bag for fleas. Sift through debris in

A-7. Collecting fleas from rodent burrows

When a rodent die-off has occurred, fleas remaining in burrows where the animals have died may be the only way to determine whether plague was the cause and the extent of plague involvement in the die-off area.

a. Collect fleas from burrows with a 12 by 12-inch piece of white flannel cloth attached to the end of a flexible plumbers snake. Insert the cloth deep into the burrow and withdraw it slowly; examine it for live fleas. If fleas are present, then place the cloth into a 1-gallon size ziplock plastic bag marked with the date and site of collection.

b. Upon returning to the laboratory, fill the bags with carbon dioxide (if available) or with a cotton ball containing Metofane to immobilize the fleas. Place the contents of the bag (including the cloth) into a white enamel pan for examination. Place fleas into vials containing 2 percent saline solution and label the vials as specified in paragraph A-8. Forward the vials to the CDC Plague Section, Fort Collins, Colorado.

A-8. Labeling rodent and flea vials

a. Remove the identification tag from the trap and place it on the rodent's hind foot (do not tag the tail). Add the rodent's body measurements to the back side of the identification tag, or attach an additional tag to the other hind foot.

b. Vial labels can be made of 1-inch pieces of 1/2-inch athletic adhesive tape. Label vials with the rodent identification number and date. Pack vials carefully and mail them with CDC Form 56.32.

A-9. Recording data

Provide the following data as indicated on CDC Form 56.32 - see Figure A-2 for a sample form:

a. Top of the form. Location, Date, Collectors, etc. Self-explanatory. Include the military installation as part of the location information.

b. Zoonoses collection number. Enter rodent collection number.

c. Species. Indicate species of the rodent; leave blank if specimen is submitted for identification.

MAMMAL – ECTOPARASITE
FIELD DATA

Sheet _____ of _____

County	State	Place	T _____ R _____ S _____
Month, Day 19_____	Collectors		

Zoonoses Coll. No.	Species	Sex	Age	Repro. Cond.	Ectos.	SPECIMENS SUBMITTED Tissue	Serum	Remarks
						Type: Results:	Dil: Results:	
Ecto. Ident.								
						Type: Results:	Dil: Results:	
Ecto. Ident.								
						Type: Results:	Dil: Results:	
Ecto. Ident.								
						Type: Results:	Dil: Results:	
Ecto. Ident.								
						Type: Results:	Dil: Results:	
Ecto. Ident.								
						Type: Results:	Dil: Results:	
Ecto. Ident.								

Ectoparasite Pools	Pool No.	Inclusive Collection Nos.	Flea Species in Pool	Results

CDC 56.32 (F. 515.7)
6/83

Figure A-2. *Sample of CDC Form 56.32.*

Zoonoses Coll. No.	Species	Sex	Age	Repro. Cond.	Ectos	SPECIMENS SUBMITTED Tissue	Serum	Remarks
Ecto. Ident.						Type: Results:	Dil. Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	
Ecto. Ident.						Type: Results:	Dil: Results:	

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d. Sex. Indicate M or F.

e. Age. Enter age if known; normally the age will be indicated as adult, juvenile, very young, old, etc.

f. Reproductive condition. Determine whether the rodent is sexually active or inactive. Indicate how the determination was made by entering testes scrotal, testes abdominal, vulva open, vulva closed, lactating, etc.

g. Ectoparasites. Indicate the number of fleas collected. If none, enter none.

h. Remarks. Add remarks as appropriate, e.g., dead in trap.

i. Remainder of form. Leave blank.

NOTE: Do not enter any information in the blocks marked "Ecto. Ident." This section is reserved for CDC use only.

A-10. Shipping specimens

a. To submit rodents to USACHPPM, DSA-W, freeze and wrap them in paper or plastic bags. Pack specimens with enough dry ice to keep them frozen for 3 days. Ship frozen rodents via air freight. Notify USACHPPM-W when shipments are made; telephone numbers are provided in paragraph A-10c.

NOTE: DO NOT put dry ice in sealed containers--if the CO_2 generated cannot escape, the container may explode.

b. Submit fleas in the collection vials after they have been sealed and labeled.

c. Send all specimens to Commander, USACHPPM, DSA-W, ATTN: ESD, Fitzsimons Army Medical Center, Aurora, CO 80045-5001; telephone DSN 943-8189/8090. An exception to this procedure involves rodents and fleas collected that are presumed to contain plague bacteria. Send these specimens directly to: Plague Section, Centers for Disease Control and Prevention, P.O. Box 2087, Fort Collins, CO 80521. Contact CDC by telephone prior to shipment of specimens for any coordinating instructions.

A-11. Rodent identification (including rabbits)

a. USACHPPM, DSA-W personnel will identify rodents to species. One or more of the publications listed in Appendix I may aid in the identification.

b. The publication *The Mammals of North America,* by E. Raymond Hall and Keith R. Kelson (The Roland Press Company, New York), may be used; it is more inclusive but is difficult to use even by a mammalogist.

c. USACHPPM, DSA-W personnel will identify rodents received using superficial characters and measurements when required. Some rodents will require skull extraction and cleaning before proper identification can be made.

d. USACHPPM, DSA-W personnel will skin rodents representing specific areas or important species and prepare them as study skins. USACHPPM, DSA-W maintains a collection of these study skins and corresponding skulls for reference purposes.

A-12. Flea identification

a. Fleas should be cleared, dehydrated, and mounted on glass slides and then examined with a compound microscope for accurate identification. The clearing process includes removing the ethyl alcohol/glycerin mixture from the specimen vial with a pasteur pipette and replacing it with a 10 percent potassium hydroxide solution (KOH).

(1) Remove the KOH solution after 24 hours (48 hours maximum) and replace with a 1.0 percent hydrochloric acid solution (HCL) to neutralize the KOH. Fleas may remain in HCL solution for a week if desired.

(2) Remove the HCL solution after 20 minutes, minimum, and replace with Cellosolve™.

(3) Allow fleas to remain in Cellosolve for 2 hours, then mount immediately in Canada balsam.

(4) Orient fleas so that the head is to the right and the legs are directed away from the mounter toward the top of the slide.

Cellosolve™ is a registered trademark of Union Carbide Corporation, 270 Park Avenue, New York, New York.

(5) Write host collection numbers on each slide prior to mounting in order to correlate each flea with the appropriate collection data.

b. Basic literature required to identify fleas includes but is not limited to those in Appendix J.

A-13. Safety

a. Personnel processing rodents should receive plague shots (boosters, if applicable); wear surgical gloves, and use insect repellent.

b. Personnel processing carnivores should be aware of coming in contact with rabies and should take necessary precautions. State contacts for rabies information are listed in Appendix K.

A-14. Materials

The following materials are required (some are optional) in order to perform rodent and flea surveys. The quantity will depend on the number of habitats to be sampled.

- Installation/local area map and compass
- Note pads and log books
- Pencils
- Watch
- Labels for traps or boxes (adhesive tape)
- Labels for vials
- Vials, 9mm
- Small and medium garbage bags, clear
- Metofane
- Anesthetizing jars, 1 large (gallon), 1 small (quart)
- Surgical cotton batting or gauze
- Bailing wire (light)
- 70 percent ethyl alcohol
- Glycerin
- Applicator sticks
- Stiff toothbrushes with white bristles (cut off all rows except one)
- White enamel pans
- White terrycloth towels
- Mammal identification literature (field guide to mammals)

- Saline solution, 2 percent (normal saline may be substituted)
- Fine tipped artist brushes
- Plumbers wire drain snake, 1/4 to 1/2-inch diameter, cut to 12 foot length, with battery clip attached to one end
- Masking tape, 1-inch
- Pliers, linemans w/wire cutter
- Insulated blood boxes, 1-cubic foot
- Heavy gloves, welders
- Disposable surgical gloves
- Liquid dishwashing soap
- Hand lens, 10x
- Ruler, 12-inch, inches and mm
- Scale, 0-500 gm
- Syringe w/needle (tuberculin)
- Nabuto strips
- Mailing envelopes, 3 x 5-inches
- CDC Form 56.28 (Field Data and Laboratory Submission Report: Plague Serologies)
- Habitat description form
- CDC Form 56.32 (Mammal-Ectoparasite Field Data)
- Medicine dropper
- Scissors, iris
- Knife, pocket
- Materials required for establishing, marking, and running trapline:

a. Collapsible live trap, 5 x 5 x 16 inches (1/2 x 1 inch wire cloth); at least 15 per sampled habitat.

b. Rigid live traps--aluminum preferable (3 x 3 x 10 inches); at least 30 per sampled habitat.

c. Engineer tape--two colors.

d. Engineer flags on wire masts.

e. Wooden stakes.

APPENDIX B

INSTALLATION CARNIVORE SEROLOGY SAMPLING

B-1. Introduction

Many carnivorous animals are known to develop a transient infection and measurable antibody response following ingestion of plague-infected rodent prey. Even in areas with low-level plague circulation among rodents, the proportion of carnivores with plague antibody is significant in relatively small population samples. Data indicates that the proportion of serologically positive carnivores and the geometric mean of positive titers (GMPT) both vary in response to variation in infection rate among rodent prey species.

B-2. Reasons for carnivore sampling

The occurrence of plague antibody titers in wild carnivores offers indirect evidence of plague infections among the wild rodents that make up those predators' diets. The number of serologically positive carnivores in a sample, the ages of such animals, the mean of positive titers, the presence of significantly high titers, and location or geographic distribution of captures are criteria that form the basis for actions. Indirect evidence of rodent plague, as shown by positive carnivore serologies, is sufficient cause to alert the medical community in an affected area to the possible human hazard. Early diagnosis of human plague is essential to successful treatment. In addition to the surveillance function, the accumulation of data over a period of time will provide substantial information on the geographic and ecological distribution of plague.

B-3. Collaborative plague studies

Collaborative plague surveillance programs based on carnivore serology have been conducted in several states, including Texas, New Mexico, Colorado, Arizona, Oregon, Idaho, Montana, Wyoming, and Washington. One of the objectives of the programs had been to define the distribution of plague activity in the western United States geographically and temporally. Through these and other studies, the major plague foci have been better defined. Data from studies both on and off Army installations have further defined the history of plague and plague potential on the installations cited throughout this document.

B-4. Serodiagnosis rationale

Serodiagnosis of disease in individuals requires both an acute and convalescent serum and the demonstration of a rise in titer considered diagnostic for the test used. In serosurveys, only one serum sample per animal is collected more or less at random, thus populations must be observed rather than individuals. One antibody-positive serum does not indicate an epizootic regardless of how high the titer is, although it does demonstrate plague activity at one time or another and in some location where the animal has been. There are three statistics to work with: (1) the distribution of titers in a population sample, (2) the percentage of animals positive in the sample, and (3) the GMPT in a sample.

B-5. About titers

The percentage of animals with detectable titers in a sample is a measure of infection rate without reference to time. The distribution of titers and the calculated GMPT, along with the percentage of animals with antibodies, helps to estimate the time frame. If earlier samples from the same population are available (somewhat akin to an acute serum from an individual) or if the ages of the individuals in the sample are available, the estimate is strengthened, particularly if young animals with antibodies are represented. Demonstration of a twofold change in titer (in GMPT) from one sampling period to the next is certainly indicative of a rise or decline in plague activity. Thus, the value of baseline data and program continuity is apparent.

B-6. Interpretation of titers

The following general rules, based on laboratory study data and combined with field data, may be useful if used conservatively:

a. A single titer of 1:256 or greater probably represents a recent infection. However, it is usually impossible to tell where the animal came from before it was trapped.

b. A titer of 1:512 probably represents multiple as well as recent challenges (but be aware of individual variation in response).

c. A population sample that has only titers of 1:256 or greater strongly suggests recent infection in the area sampled; inversely, a sample that has only titers of less than 1:128 suggests much earlier infection with nothing current.

d. A GMPT in excess of 1:100 with a normal distribution of titers and sufficient sample size (25 or more) probably indicates recent and perhaps current plague activity.

B-7. When to sample

Sampling large carnivores (e.g. coyote, bobcat) during February-April can give evidence of plague activity. The presence of titers may indicate newly introduced plague or latent infections that reactivate when animals become active following hibernation. In the absence of other plague indicators (dead or dying rodents, human cases, etc.) positive carnivore serologies indicate the need for increased surveillance of highly susceptible rodents (rock squirrels, California ground squirrels, and prairie dogs). The presence of high titers (1:256 or greater) or a GMPT in excess of 1:100 indicates the need to collect serologies from small carnivores in critical areas as well.

B-8. Critical areas

A critical area is a rock squirrel, California ground squirrel, or prairie dog habitat in or near areas of high human activity, i.e., picnic grounds, housing areas, troop training areas. Trapping small carnivores in the critical areas will give an accurate indication in the immediate area since their average range (one-half to two square miles) is much less than larger carnivores. Titers are normally considered significant when the geometric mean of positive titers is in excess of 1:100 from a sample size of 25 or more, or if 25-30 percent of the serologies have titers of 1:256 or greater. The CDC, Fort Collins, Colorado will determine the significance of the titers.

B-9. Number of animals sampled

When required, live trap a minimum of 2 small carnivores, (i.e., skunks, badgers, weasels, ringtails) in each critical area of 1/2 square mile or less. In areas larger than 1/2 square mile, live trap an additional carnivore for each additional 1/2 square mile; a sample size of 6 carnivores per area is adequate. For example, trap 3 carnivores in an area of 1 square mile, 4 in an area of 1-1/2 square miles, 5 in an area of 2 square miles, and six in areas 2-1/2 square miles or larger. Trap the animals from different locations in the area if possible. If the critical area is in a ravine or along a rock ledge or stream, live trap a minimum of 2 small carnivores in an area of 1 mile or less in length. Trap an additional carnivore for each additional 1 mile with a maximum of 6 carnivores per area.

B-10. Serology numbers for small carnivores

In some areas, it may be difficult to trap the recommended minimum number of small carnivores in a reasonable length of time. A reasonable trapping success would be one small carnivore per 20 to 40 trap nights (one trap night equals one trap set overnight). In many cases, a minimum of 40 trap nights may be necessary for capturing each required carnivore. Past data indicate that carnivore serologies from areas experiencing plague outbreaks in wild rodents are 50-80 percent plague positive; therefore, the proposed small carnivore serology numbers should indicate if plague is active in or near a critical area.

B-11. Considerations for carnivore serology studies

a. Determining factors. The need for, and type of carnivore serology studies varies from one installation to the next. Factors to consider include past and current status of plague on the installation and in the surrounding community; number of plague susceptible rodents/colonies present; anticipated human use in potential plague enzootic areas; and other biological, ecological, and climatological variables. Advice on conducting carnivore serologies at a particular installation may be obtained from this Center and/or the CDC Plague Section, Fort Collins, Colorado.

b. Methods. The methods used for obtaining blood samples from captured predators outlined below have been extracted from the CDC protocol for collection and submission of blood samples.

(1) *Filter paper strip technique.*

(a) If the animal is still alive, make a small cut on an exposed vein (e.g., ear, leg, etc.) to produce blood and obtain a sample. If the animal has recently died, cut into any of the major veins immediately after death to obtain a blood sample. If the animal has been dead for a longer period of time, the blood in the vessels will be clotted. Under these circumstances, open the chest cavity, expose the heart and cut it open and insert the narrow end of the paper strip to absorb some of the heart blood. Wear rubber gloves during this procedure. With either method, the entire narrow portion of the filter paper (see Figure B-1) should be soaked with blood. Blot excess blood with a clean paper towel.

Figure B-1. *The Nubuto filter paper strip. Approximately 2/3 of the paper strip must be completely saturated with blood.*

(b) Allow the filter paper sample to air dry, then place it in a mailing envelope (see Figure B-2).

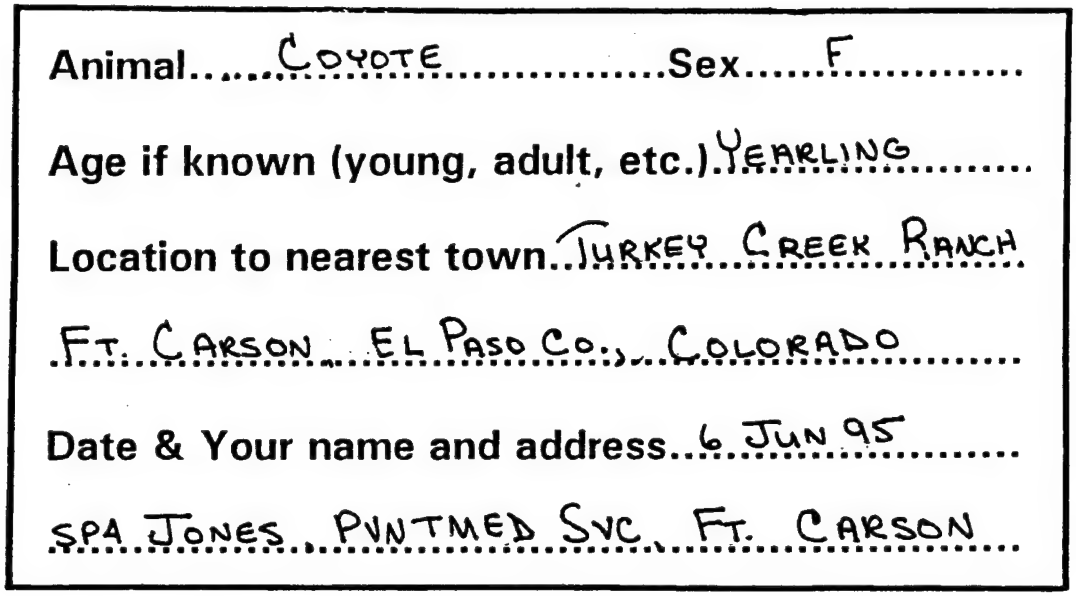


Figure B-2. *Mailing envelope.*

(c) Each space on the envelope containing a blood specimen must be filled out as completely as possible. On the mailing envelope, provide the following information:

- The town where the capture site was located. (It is important to list the town name as it would appear on a standard highway map to provide accurate geographic data.)

- The county where the capture site is located.

- The name of the installation, and an accurate geographical description of the area (use grid coordinates if necessary).

- The best estimate of the animal's age (juvenile, yearling, immature, adult, etc.).

- The animal's sex (use "F" for female and "M" for male).

NOTE: Filter strips and mailing envelopes are available from the CDC, Fort Collins, Colorado.

(2) *Whole serum collection and submission.*

(a) Use a vacutainer or syringe to take blood from appropriate veins or the heart of live animals. If animals are dead but not putrefied, open the chest cavity, and remove blood from the pool formed in the pericardial cavity. Five to 10 milliliters (ml) of whole blood is recommended.

(b) Allow samples to clot for 12-24 hours in 16 mm x 125 mm screw-capped tubes - or anything you have approximating such - and lay horizontally in a cool place. Refrigeration of blood (while clotting) or centrifugation before the clot forms will produce usable serum, but interference factors are introduced which reduce the sensitivity of the PHA test. Use a pipette to transfer serum to smaller serum tubes. Then, insert a stopper, label the tube and mail with data sheets. Refrigerate sera if held following separation from the clot. DO NOT FREEZE. Refrigerated samples may be kept for up to 10 days.

NOTE: Involve wildlife personnel, professional trappers, or other individuals familiar with trapping carnivores as much as possible, since they are usually familiar with handling captured animals. Often, they will collect the blood samples needed. At other times, another individual may be required to accompany the trapper. Release trapped animals following blood sampling; dispose properly of dead animals.

c. Collection and laboratory data.

(1) Specimens submitted are listed with appropriate field data on Field Data and Laboratory Submission Report: Plague Serologies, CDC 56.28 (see Figure B-3, Sample Form).

(2) Laboratory results are entered on the form by the Plague Section, CDC, Fort Collins. A copy of the completed form is returned to the sender.

FIELD DATA AND LABORATORY SUBMISSION REPORT: PLAGUE SEROLOGIES

FOR LAB USE ONLY

INCL. ACC. NO. _____

DATE REC'D. _____

UNIT FILE NO. _____

Sent by _____

Agency _____

Date _____ Page _____ of _____

FIELD NO.	COLLECTOR	LOCALITY*	DATE	SPECIES	AGE	SEX	TYPE** SPECIMEN	ACC. NO.	RESULTS

*Distance and direction from nearest map locality (town or place), county, state

**Whole serum, diluted serum (show dilution), nobuto strip

CDC 56.28 (formerly 3.937)
2/83

Figure B-3. *Sample of Plague Serologies, CDC 56.28.*

APPENDIX C

MAMMAL AND FLEA SPECIES COLLECTED FROM SELECTED ARMY INSTALLATIONS

LIST OF FLEA SPECIES COLLECTED
(REPRESENTS ALL INSTALLATIONS COMBINED)

1. *Amegabothris abantis*
2. *Aetheca wagneri*
3. *Amaradix euphorbi*
4. *Anomiopsyllus falsicalifornicus*
5. *A. nudatus*
6. *Atyphloceras echis*
7. *A. multidentatus*
8. *Callistopyllus terinus*
9. *Carteretta carteri*
10. *Catallagia charlottensis*
11. *C. wymani*
12. *Cediopsylla inaequalis*
13. *Ceratophyllus ciliatus*
14. *Corrodopsylla curvata*
15. *Ctenocephalides felis*
16. *C. pseudagyrtes*
17. *Diamanus montanus*
18. *Delotelis hollandi*
19. *Echidnophaga gallinacea*
20. *Epitedia scapani*
21. *E. stanfordi*
22. *E. wenmanni*
23. *Euhoplopsyllus glacialis*
24. *Eumolpianus cyrturus*
25. *E. eumolpi*
26. *Hoplopsyllus anomalus*
27. *Hystrichopsylla occidentalis*
28. *Hystrichopyslla* sp.
29. *Malaraeus sinomus*
30. *M. telchinus*
31. *Malaraeus* sp.
32. *Megarthroglossus bisetus*
33. *M. weaveri*
34. *M. wilsoni*
35. *Meringis altipecten*
36. *M. bilsingi*
37. *M. dipodomys*
38. *M. nidi*
39. *M. parkeri*
40. *M. rectus*
41. *Meringis* sp.
42. *Odontopsylus dentatus*
43. *Opisocrostis hirsutus*
44. *O. tuberculatis cynomuris*
45. *Orchopeas howardi*
46. *O. leucopus*
47. *O. neotomae*
48. *O. sexdentatus*
49. *Oropsylla idahoensis*
50. *Oxypsylla keeni*
51. *O. nesiotus*
52. *Peromyscopsylla draco*
53. *P. hesperomys*
54. *P. selensis*
55. *Phalacropsylla paradisea*
56. *Pleochaetis exilis*
57. *Plusaetis asetus*
58. *P. sibynus*
59. *Polygenis gwyni*
60. *Pulex irritans*
61. *P. simulans*
62. *Rhadinopsylla fraterna*
63. *R. sectilis*
64. *Stenistomera alpina*
65. *S. americana*
66. *Thrassis aridis*
67. *T. bacchi*
68. *T. fotus*

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT BLISS

Common Name	Species Name	Fleas*
Black-tailed prairie dog**	*Cynomys ludovicianus*	
Merriam's kangaroo rat	*Dipodomys merriami*	35,36
Ord's kangaroo rat	*Dipodomys ordii*	35,36
White-throated wood rat	*Neotoma albigula*	48
Southern plains wood rat	*Neotoma micropus*	
Northern grasshopper mouse	*Onychomys leucogaster*	36,67
Southern grasshopper mouse	*Onochomys torridus*	56
Silky pocket mouse	*Perognathus flavus*	
Hispid pocket mouse	*Perognathus hispidus*	
Rock pocket mouse	*Perognathus intermedius*	
Merriam's pocket mouse	*Perognathus merriami*	
Rock mouse	*Peromyscus difficullus*	
Cactus mouse	*Peromyscus eremicus*	46
Deer mouse	*Peromyscus maniculatus*	46
Spotted ground squirrel	*Spermophilus spilosoma*	

* numbers correspond to flea species list
** this species observed but not collected

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT CARSON

Common Name	Species Name	Fleas*
Black-tailed prairie dog	*Cynomys ludovicianus*	43,44
Ord's kangaroo rat	*Dipodomys ordii*	2,38,39,66
Long-tailed vole	*Microtus longicaudus*	
Mountain vole	*Microtus montanus*	2,46
Prairie vole	*Microtus ochrogaster*	2,22,25,30,46
Meadow vole	*Microtus pennsylvanicus*	2,25,30,46
Long-tailed weasel	*Mustela frenata*	
Bushy-tailed wood rat	*Neotoma cinerea*	6
Eastern wood rat	*Neotoma floridana*	
Mexican wood rat	*Neotoma mexicana*	2,5,23,30,33, 36,46,47,64,65
Northern grasshopper mouse	*Onychomys leucogaster*	2,22,37,38, 39,56,66,67
Plains pocket mouse	*Perognathus flavescens*	
Silky pocket mouse	*Perognathus flavus*	2,5,41,47
Brush mouse	*Peromyscus boylii*	2,30,46
Rock mouse	*Peromyscus difficillus*	2,21,22,30,46
White-footed mouse	*Peromyscus leucopus*	2,3,22,26,28, 30,34,39,46, 65,66
Deer mouse	*Peromyscus maniculatus*	2,3,5,6,8, 17,19,21,22,23, 25,30,34,39,46, 47,48,49,53,63, 64,65,66,68
Pinon mouse	*Peromyscus truei*	2,5,21,25, 34,46,67
Western harvest mouse	*Reithrodontomys megalotis*	2,5,46,68
Plains harvest mouse	*Reithrodontomys montanus*	
Spotted ground squirrel	*Spermophilus spilosoma*	
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	2,17,22,23, 30,46
Rock squirrel	*Spermophilus variegatus*	2,17,25,26
Desert cottontail	*Sylvilagus auduboni*	2,12,23
Least chipmunk	*Tamias minimus*	2,25
Colorado chipmunk	*Tamias quadrivitattus*	2,17,25,26

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT HUACHUCA

Common Name	Species Name	Fleas*
Merriam's kangaroo rat	*Dipodomys merriami*	56
White-throated wood rat	*Neotoma albigula*	5,24,26,29, 31,48,53,55,59
Mexican wood rat	*Neotoma mexicana*	17,19,21,48
Northern grasshopper mouse	*Onychomys leucogaster*	
Southern grasshopper mouse	*Onychomys torridus*	56
Silky pocket mouse	*Perognathus flavus*	
Hispid pocket mouse	*Perognathus hispidus*	59
Rock pocket mouse	*Perognathus intermedius*	
Desert pocket mouse	*Perognathus penicillatus*	26
Great Basin pocket mouse	*Perognathus parvus*	
Long-tailed pocket mouse	*Perognathus formosus*	
Bailey's pocket mouse	*Perognathus baileyi*	
Brush mouse	*Peromyscus boylii*	21,26,55,58
Canyon mouse	*Peromyscus crinitus*	52
Rock mouse	*Peromyscus difficillus*	
Cactus mouse	*Peromyscus eremicus*	29,58
White-footed mouse	*Peromyscus leucopus*	
Deer mouse	*Peromyscus maniculatus*	5,17,29,31,46
White-ankled mouse	*Peromyscus pectoralis*	53
Western harvest mouse	*Reithrodontomys megalotis*	
Plains harvest mouse	*Reithrodontomys montanus*	54
Fulvous harvest mouse	*Reithrodontomys fulvescens*	
Hispid cotton rat	*Sigmodon hispidus*	52,53,59
Yellow-nosed cotton rat	*Sigmodon ochrognathus*	48,59
Least cotton rat	*Sigmodon minimus*	59
Spotted ground squirrel	*Spermophilus spilosoma*	
Rock squirrel	*Spermophilus variegatus*	5,17,19,26, 45,50,61
Arizona grey squirrel	*Sciurus arizonensis*	
Mountain cottontail	*Sylvilagus nuttallii*	17,23

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT HUNTER-LIGGETT

Common Name	Species Name	Fleas*
Heermann's kangaroo rat	*Dipodomys heermanni*	66
Giant kangaroo rat	*Dipodomys ingens*	
Santa Cruz kangaroo rat	*Dipodomys venustus*	
California vole	*Microtus californicus*	2,26,30
House mouse	*Mus musculus*	
Dusky-footed wood rat	*Neotoma fuscipes*	2,4,48
Desert wood rat	*Neotoma lepida*	48
California pocket mouse	*Perognathus californicus*	9,26
California mouse	*Peromyscus californicus*	30
Brush mouse	*Peromyscus boylii*	2,26,30,53
Deer mouse	*Peromyscus maniculatus*	2,7,30,53
Pinon mouse	*Peromyscus truei*	2,9,17,26,30,53
Western harvest mouse	*Reithrodontomys megalotis*	
California ground squirrel	*Spermophilus beecheyi*	17,19,26,61
Merriam's chipmunk	*Tamias merriami*	

* numbers correspond to flea species list

LIST OF MAMMALS AND FLEA SPECIES COLLECTED AT FORT LEWIS

Common Name	Species Name	Fleas*
Boreal redback vole	*Clethrionomys gapperi*	1
Snowshoe hare	*Lepus americanus*	
Long-tailed vole	*Microtus longicaudus*	1,7,15,20,27 2,50,54,63
Mountain vole	*Microtus montanus*	1,7,10,18, 27,54,63
Oregon vole	*Microtus oregoni*	1,7,10,13,18,20, 27,50,54,63
Meadow vole	*Microtus pennsylvanicus*	1,10,50
Richardson's vole	*Microtus richardsoni*	20
Townsend's vole	*Microtus townsendi*	1,10,53
Short-tailed weasel	*Mustela erminea*	
Long-tailed weasel	*Mustela frenata*	
Deer mouse	*Peromyscus manicualtus*	1,2,7,10,13, 18,20,27,50, 53,54,63
Masked shrew	*Sorex cinereas*	
Trowbridge's shrew	*Sorex trowbridgii*	2,14,20
Vagrant shrew	*Sorex vagrans*	
Eastern cottontail	*Sylvilagus floridanus*	
Mountain cottontail	*Sylvilagus nuttallii*	
Yellow pine chipmunk	*Tamias amoenus*	
Townsend's chipmunk	*Tamias townsendi*	13
Pacific jumping mouse	*Zapus trinotatus*	1,2,10

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT NAVAJO DEPOT ACTIVITY

Common Name	Species Name	Fleas*
Gunnison's prairie dog**	*Cynomys gunnisoni*	
Mexican vole	*Microtus mexicanus*	2,16,17,21, 30,53,57
Eastern wood rat	*Neotoma floridana*	2,47
Mexican wood rat	*Neotoma mexicanus*	2,5,17,25,30, 32,47,57
Brush mouse	*Peromyscus boylii*	2,5,53
Cactus mouse	*Peromyscus eremicus*	2,30,58
Deer mouse	*Peromyscus maniculatus*	2,17,21,25,27, 30,43,47,49,53, 57,58
Pinon mouse	*Peromyscus truei*	2,5,30,57
Western harvest mouse	*Reithrodontomys megalotis*	2
Unknown harvest mouse	*Reithrodontomys* species	2,30
Golden-mantled ground squirrel	*Spermophilus lateralis*	17,21,30,47,49
Rock squirrel**	*Spermophilus variegatus*	
Spotted ground squirrel	*Spermophilus spilosoma*	67
Desert cottontail	*Sylvilagus audoboni*	
Greyneck chipmunk	*Tamias cinereicollis*	2,17,25,49
Colorado chipmuck	*Tamias quadrivitattus*	25
Unknown chipmunk	*Tamias* species	67

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT ORD

Common Name	Species Name	Fleas*
Opossum	*Didelphis marsupialis*	15,30,50,60
Heermann's kangaroo rat	*Dipodomys heermanni*	
Santa Cruz kangaroo rat	*Dipodomys venustus*	
California vole	*Microtus californicus*	7,11,28,30,50
White-throated wood rat	*Neotoma albigula*	
Dusky-footed wood rat	*Neotoma fuscipes*	4,7,15,19,23, 26,28,30,48,50
California pocket mouse	*Perognathus californicus*	9,30,50,66
California mouse	*Peromyscus californicus*	4,7,9,30,48, 50,51,66
Brush mouse	*Peromyscus boylii*	4,7,30,50,51
Deer mouse	*Peromyscus maniculatus*	7,9,11,23,26, 30,48,50,51,66
Pinon mouse	*Peromyscus truei*	7,11,28,30, 48,50
Western harvest mouse	*Reithrodontomys megalotis*	50
California grouind squirrel	*Spermophilus beecheyi*	17,19,26
Desert cottontail	*Sylvilagus audoboni*	12,23,42

* numbers correspond to flea species list
** this species observed but not collected

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT PUEBLO DEPOT ACTIVITY

Common Name	Species Name	Fleas*
Black-tailed prairie dog	*Cynomys ludovicianus*	43,44
Ord's kangaroo rat	*Dipodomys ordii*	2,23,34,38,39 48,53,66,68
Mountain vole	*Microtus montanus*	
Prairie vole	*Microtus ochrogaster*	46
House mouse	*Mus musculus*	
White-throated wood rat	*Neotoma albigula*	2,5,22,46,48,66
Bushy-tailed wood rat	*Neotoma cinerea*	
Eastern wood rat	*Neotoma floridana*	5,23,39,46,48
Northern grasshopper mouse	*Onychomys leucogaster*	53,56,66
Silky pocket mouse	*Perognathus flavus*	
Brush mouse	*Peromyscus boylii*	
Rock mouse	*Peromyscus difficullus*	2,22,53
White-footed mouse	*Peromyscus leucopus*	2,38,39,46,53,66
Deer mouse	*Peromyscus maniculatus*	2,46,48,53,66
Western harvest mouse	*Reithrodontomys megalotis*	2,46,66
Hispid cotton rat	*Sigmodon hispidus*	48
Spotted ground squirrel	*Spermophilus spilosoma*	5
Desert cottontail	*Sylvilagus audoboni*	12,23

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT CAMP ROBERTS

Common Name	Species Name	Fleas*
California vole	*Microtus californicus*	7,19,30
Dusky-footed wood rat	*Neotoma fuscipes*	7,23,48
California mouse	*Peromyscus californicus*	30
Brush mouse	*Peromyscus boylii*	2,30
Deer mouse	*Peromyscus maniculatus*	2,4,30,48
Pinon mouse	*Peromyscus truei*	2,30
Western harvest mouse	*Reithrodontomys megalotis*	
California grouind squirrel	*Spermophilus beecheyi*	17,19,26
Desert cottontail	*Sylvilagus audoboni*	12,23
Brush rabbit	*Sylvilagus bachmani*	23
Unknown cottontail	*Sylvilagus* species	12,23

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT ROCKY MOUNTAIN ARSENAL

Common Name	Species Name	Fleas*
Black-tailed prairie dog	*Cynomys ludovicianus*	43,44
Ord's kangaroo rat	*Dipodomys ordii*	
Striped skunk	*Mephitis mephitis*	61
Mountain vole	*Microtus montanus*	46
Prairie vole	*Microtus ochrogaster*	46
Meadow vole	*Microtus pennsylvanicus*	2,46,65
House mouse	*Mus musculus*	
Long-tailed weasel	*Mustela frenata*	
Muskrat	*Ondatra zibethicus*	
Plains pocket mouse	*Perognathus flavescens*	
Silky pocket mouse	*Perognathus flavus*	
Deer mouse	*Peromyscus maniculatus*	2,22,23,43, 46,65
Western harvest mouse	*Reithrodontomys megalotis*	46
Eastern fox squirrel	*Sciurus niger*	
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	46,68
Desert cottontail	*Sylvilagus audoboni*	12,23
Eastern cottontail	*Sylvilagus floridanus*	12,23

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT SIERRA ARMY DEPOT

Common Name	Species Name	Fleas*
Merriam's kangaroo rat	*Dipodomys merriami*	66
Great Basin kangaroo rat	*Dipodomys microps*	39
Ord's kangaroo rat	*Dipodomys ordii*	2,39,66,67
Bushy-tailed wood rat	*Neotoma cinerea*	
Dusky-footed wood rat	*Neotoma fuscipes*	
Northern grasshopper mouse	*Onychomys leucogaster*	2
Deer mouse	*Peromyscus maniculatus*	2,48
Canyon mouse	*Peromyscus crinitus*	2
Plains harvest mouse	*Reithrodontomys montanus*	46
Western harvest mouse	*Reithrodontomys megalotis*	
California ground squirrel	*Speromophilus beecheyi*	17,19,26,67
White-tailed antelope squirrel	*Ammospermophilus leucurus*	2,17,26,28, 39,66,67
Great Basin pocket mouse	*Perognathus parvus*	
Mountain cottontail	*Sylvilagus nuttallii*	39,66
Least chipmunk	*Tamias minimus*	2,24,25,26,48

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT TOOELE ARMY DEPOT

Common Name	Species Name	Fleas*
Great Basin kangaroo rat	*Dipodomys microps*	39
Ord's kangaroo rat	*Dipodomys ordii*	5,12
Deer mouse	*Peromyscus maniculatus*	2,17,21,29,30, 31,39,46,50, 53,62,67
Western harvest mouse	*Reithrodontomys megalotis*	
Great Basin pocket mouse	*Perognathus parvus*	39
Longtailed pocket mouse	*Perognathus formosus*	2,39
Rock squirrel	*Spermophilus variegatus*	17,26
Mountain cottontail	*Sylgilagus nuttallii*	12
Least chipmunk	*Tamias minimus*	25

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT UMATILLA DEPOT ACTIVITY

Common Name	Species Name	Fleas*
Ord's kangaroo rat	*Dipodomys ordii*	2,39
Mountain vole	*Microtus montanus*	
House mouse	*Mus musculus*	39
Deer mouse	*Peromyscus maniculatus*	2
Great Basin pocket mouse	*Perognathus parvus*	2,39
Norway rat	*Rattus norvegicus*	2
Mountain cottontail	*Sylvilagus nuttallii*	12

* numbers correspond to flea species list

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT WHITE SANDS MISSILE RANGE

Common Name	Species Name	Fleas*
White-tailed antelope ground squirrel	*Ammospermophilus leucerus*	
Black-tailed prairie dog**	*Cynomys ludovicianus*	
Merriam's kangaroo rat	*Dipodomys merriami*	35,38,40,67
Ord's kangaroo rat	*Dipodomys ordii*	5,17,35,36, 38,67
Banner-tailed kangaroo rat	*Dipodomys spectabilis*	35,40,66
Greyneck chipmunk	*Tamias cinereicollis*	
White-throated wood rat	*Neotoma albigula*	5,19,48
Southern plains wood rat	*Neotoma micropus*	
Northern grasshopper mouse	*Onychomys leucogaster*	35,36,67
Southern grasshopper mouse	*Onychomys torridus*	66,67
Silky pocket mouse	*Perognathus flavus*	
Rock pocket mouse	*Perognathus intermedius*	
Desert pocket mouse	*Perognathus pennicillatus*	67
Brush mouse	*Peromyscus boylii*	
Cactus mouse	*Peromyscus eremicus*	23
White-footed mouse	*Peromyscus leucopus*	35,46,67
Deer mouse	*Peromyscus maniculatus*	
Pinon mouse	*Peromyscus truei*	21,46
Western harvest mouse	*Reithrodontomys megalotis*	
Hispid cotton rat	*Sigmodon hispidus*	46,59
Spotted ground squirrel	*Spermophilus spilosoma*	32,46,67
Rock squirrel	*Spermophilus variegatus*	17,23,26
Desert cottontail	*Sylvilagus audoboni*	19,23

* numbers correspond to flea species list

** this species observed but not collected

LIST OF MAMMAL AND FLEA SPECIES COLLECTED AT FORT WINGATE DEPOT ACTIVITY

Common Name	Species Name	Fleas*
Gunnison's prairie dog**	*Cynomys gunnisoni*	
Great Basin kangaroo rat	*Dipodomys microps*	
Ord's kangaroo rat	*Dipodomys ordii*	
White-throated wood rat	*Neotoma albigula*	
Bushy-tailed wood rat	*Neotoma cinerea*	
Mexican wood rat	*Neotoma mexicana*	32
Southern plains wood rat	*Neotoma micropus*	19,32
Stephens' wood rat	*Neotoma stephensi*	2,64
Brush mouse	*Peromyscys boylii*	2,32,53
Cactus mouse	*Peromyscus eremicus*	2
Deer mouse	*Peromyscus maniculatus*	2,5,19,21,23,53
Pinon mouse	*Peromyscus truei*	2,21,25,32, 53,57
Unknown field mouse	*Peromyscus* species	2,30
Western harvest mouse	*Reithrodontomys megalotis*	
Rock squirrel	*Spermophilus variegatus*	2,17,26
Cliff chipmunk	*Tamias dorsalis*	25

* numbers correspond to flea species list
** this species observed but not collected

APPENDIX D

SHORT TALK ABOUT PLAGUE

D-1. Introduction of plague

It is believed that plague was introduced into the United States aboard rat-infested ships around 1900. From 1900-1925, human plague epidemics in port cities resulted in 432 cases with 283 deaths; these cases were associated with urban rat epizootics (epidemics in animal populations). Plague is now primarily a disease of small wild animals. Since 1925, all human cases have been sporadic and associated with domestic or wild animals and their fleas. Usually the victims have encroached upon the habitats of these animals.

D-2. Plague in the United States

Plague in the United States appears to be limited to the western third of the country. It is most commonly associated with pinon-juniper and pine-oak woodland habitats between 5,000 and 9,000 feet, but it is also found in many other habitat types. Human cases in recent years have occurred in New Mexico, California, Colorado, Arizona, Utah, Idaho, Texas, Nevada, Montana, Wyoming, Washington, Oregon, and Oklahoma. Since 1965, the number of human cases in the United States has greatly increased. More cases have been reported within the past 25 years than in the previous 50 years. Most cases occur in persons under 20 years old, during the summer months, and within a 1-mile radius of the home.

D-3. The disease

Plague is caused by the bacterium *Yersinia pestis*. It can infect the lymph system (bubonic plague), the circulatory system (septicemic plague), and the respiratory system (pneumonic plague). Plague can usually be cured with appropriate antibiotics if diagnosed early; however, when plague becomes septicemic or pneumonic, chances of survival are greatly reduced. Bubonic plague is usually the result of bites from infected fleas, or of direct infection when handling sick or dead animals. Pneumonic and septicemic plague may result from infection with the bubonic form. Pneumonic plague may also result from inhalation of infective droplets coughed up by another individual (or animal, as in the case with plague infected cats) with pneumonic plague. This form of plague is highly contagious.

D-4. Susceptibility

Plague can infect most wild and domestic mammals although some species are much more susceptible than others. Much of the time, plague is believed to circulate in small rodent populations such as mice causing little mortality. Occasionally, populations of more susceptible mammals (i.e., prairie dogs, rock squirrels and California ground squirrels) experience plague outbreaks. During such an outbreak, the potential for human exposure to infected mammals and fleas is greatly increased.

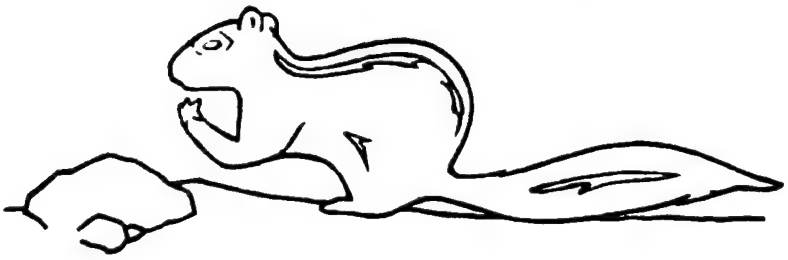
D-5. Plague on Army installations

Plague is known to occur on or near a number of Army installations in the western United States. Most of these installations have populations of highly susceptible rodents. These rodent populations have increased since 1972 at some installations because the use of rodent poisons having secondary effects (poisons that can kill carnivores that feed on poisoned rodents) was restricted from 1972 to 1982, and their use has been avoided since that time. In 1976, the Army initiated a comprehensive plague-surveillance program at selected installations to reduce the human plague potential.

D-6. Minimizing plague

Exposure to plague may be minimized by: avoiding contact with sick or dead rodents, avoiding areas with rodent burrows (especially if no live rodents are present), wearing clothing to reduce flea bites, and using insect repellents.

PLAGUE WARNING



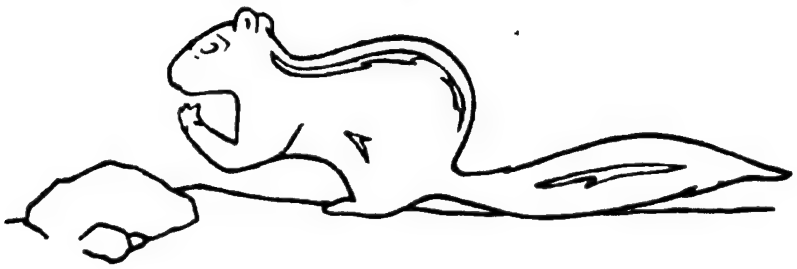
CHIPMUNKS, GROUND SQUIRRELS OR OTHER WILD RODENTS IN THIS AREA MAY BE INFECTED WITH PLAGUE. PLAGUE MAY BE TRANSMITTED TO HUMANS BY THE BITE OF AN INFECTED FLEA OR BY HANDLING AN INFECTED ANIMAL.

USE THESE PRECAUTIONS

1. **Avoid all contact with chipmunks, squirrels or other wild animals—DO NOT FEED.**
2. **Do not camp, rest, or sleep near animal burrows. AVOID ANIMAL FLEAS.**
3. **Protect your pets with flea powder or flea collars—OR LEAVE PETS HOME.**
4. **See a physician if you become ill within a week of your visit. THE DISEASE IS CURABLE WHEN DIAGNOSED EARLY.**
5. **DO NOT TOUCH sick or dead animals. REPORT THEM TO:**

Figure D-1. *Plague warning sign (English)*

AVISO DE PLAGA



ARDILLAS Y TODAS SUS VARIEDADES U OTROS RATONES DE MONTE EN ESTA AREA PUEDEN ESTAR INFESTADOS CON UNA PLAGA INFECCIOSA. ESTA PLAGA INFECCIOSA PUEDE SER TRASMITIDA A LOS SERES HUMANOS POR MEDIO DE MORDIDAS DE UNA MOSCA INFESTADA O POR EL SIMPLE HECHO DE TOCAR UNO DE ESTOS ANIMALES INFESTADOS.

USE ESTAS PRECAUCIONES

1. EVITE TODO CONTACTO CON ARDILLAS Y TODAS SUS VARIEDADES U OTRO RATON DE MONTE - NO LES DE ALIMENTOS.
2. NO ACAMPE, DESCANSE O DUERMA CERCA DE SUS CUEVAS. EVITE CONTACTO CON MOSCAS DE ESTOS ANIMALES.
3. PROTEJA SUS ANIMALES DOMESTICOS CON POLVO DE GARRAPATAS O CON COLLARES ESPECIALES DE GARRAPATAS.- MEJOR DEJAR SUS ANIMALES EN CASA.
4. VEA UN MEDICO EN CASO DE QUE SE SIENTA ENFERMO DENTRO DE UNA SEMANA DE SU VISITA. ESTA ENFERMEDAD SE PUEDE CURAR SI SE TRATA ENSEGUIDA.
5. NO TOQUE NINGUN ANIMAL ENFERMO O MUERTO. REPORTELO A:

Figure D-2. *Plague warning sign (Spanish)*

APPENDIX E

REPELLENTS

E-1. Available products

Several repellent products are available through the Defense General Supply Center (DGSC) or Self Service Supply System. When used according to label directions in conjunction with the proper wearing of the uniform, they provide personal protection against a wide variety of medically important insect/arthropod pests. Availability and current pricing can be obtained by calling the DGSC at DSN 695-4865.

a. Insect repellent, personal application, (3M™/EPA 58007-1), 33 percent deet, NSN 6840-01-0284-3982. This product is available in lotion form (cream, 2 fluid ounces).

b. Insect repellent stick, personal application, 33 percent deet, NSN 6840-00-142-8965. This product is more difficult to apply to large areas of exposed skin than the lotion mentioned above.

c. Insect repellent, clothing application, aerosol, 0.5 percent permethrin, NSN 6840-01-278-1336. The product provides protection from fleas through 6 launderings. Permethrin is the preferred clothing repellent when working in a flea-infested area.

d. Insect repellent, clothing application, 40 percent permethrin, NSN 6840-01-334-2666. The contents are added to 2 gallons of water and applied with the 2-gallon sprayer from a field sanitation kit at a pressure of 50 pounds per square inch. This product when applied to field uniforms will provide protection from fleas. Since most sprayers are not equipped with the required pressure gauge (NSN 3740-01-332-8746), it will be necessary to obtain a pressure gauge and filter (NSN 4330-01-332-1639) in order to complete the retrofitting. Proper application can provide protection for the normal life of the uniform, depending on climate.

e. Insect repellent, clothing application, 75 percent deet, 25 percent ethanol, NSN 6840-00-753-4963.

E-2. Further guidance

Detailed directions for the use of these and other repellents can be found in the U.S. Army Environmental Hygiene Agency Technical Guide (TG) 174, *Personal Protective Techniques Against Insects and Other Arthropods of Military Significance.*

3M™ is a trademark of Minnesota Mining and Manufacturing Co., St Paul, Minnesota.

APPENDIX F

STATE HEALTH DEPARTMENT TELEPHONE NUMBERS

ARIZONA	602-542-1024
CALIFORNIA	916-657-1425
COLORADO	303-692-2000
IDAHO	208-334-5945
MONTANA	406-444-2544
NEBRASKA	402-471-2133
NEVADA	702-687-4740
NEW MEXICO	505-827-2395
NORTH DAKOTA	701-328-2372
OKLAHOMA	405-271-4200
OREGON	503-731-4000
SOUTH DAKOTA	605-773-3361
TEXAS	512-458-7111
UTAH	801-538-6111
WASHINGTON	360-753-5871
WYOMING	307-777-7656

APPENDIX G

STATE/FEDERAL CONTACTS FOR VECTOR CONTROL INFORMATION

FEDERAL	Ken Gage, Ph.D. Plague Section Centers for Disease Control and Prevention P.O. Box 2087, Fort Collins, CO 80521	303-221-6450
ARIZONA	Craig Levy, Ph.D. Vector Control	602-250-5917
CALIFORNIA	Kevin Reilly, DVM Vector Borne Disease Section	916-324-3738
COLORADO	John Pape, Zoonoses Control Ted Davis, Vector Control Specialist	303-692-2628 303-692-3644
IDAHO	Allen Stanford Division of Environmental Quality	208-334-0577
MONTANA	Kenneth L. Quickenden Vector Control	406-444-2408 406-444-5303
NEBRASKA	Wayne Cramer Department of Health	402-471-2541
NEVADA	James E. Pierce Bureau of Health Protection Services	702-687-4750
NEW MEXICO	Ted L. Brown Department of Environment	505-474-4410
NORTH DAKOTA	Mike Trythall Dir., Division of Microbiology	701-328-5262
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APPENDIX H

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	Phone Number:	916-979-2675
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	Phone Number:	303-969-6560
IDAHO	Address:	1828 Airport Way Boise, ID 83705
	Phone Number:	208-334-1440

MONTANA	Address:	P.O. Box 1938 Billings, MT 59103
	Phone Number:	406-657-6464
NEBRASKA	Address:	5940 S. 58th Street P.O. Box 81866 Lincoln, NE 68501
	Phone Number:	402-434-2340
NEVADA	Address:	4600 Kietzke Lane, Building O-260 Reno, NV 89502
	Phone Number:	702-784-5081
NEW MEXICO	Address:	2113 Osuna Road, NE Suite B Albuquerque, NM 87113-1001
	Phone Number:	505-761-4640
NORTH DAKOTA	Address:	1824 N. 11th Street Bismarck, ND 58501-1913
	Phone Number:	701-250-4407
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	Phone Number:	405-521-4039

OREGON	Address:	Center Building 205 Suite 110 2600 S., E. 98th Street Portland, OR 97266
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SOUTH DAKOTA	Address:	See Nebraska for servicing office
	Phone Number:	402-434-2340
TEXAS	Address:	P.O. Box 100410 San Antonio, TX 78201-1710
	Phone Number:	210-731-3451
UTAH	Address:	P.O. Box 26976 Salt Lake City, UT 84126-0976
	Phone Number:	801-975-3315
WASHINGTON	Address:	720 O'Leary Street Olympia, WA 98502
	Phone Number:	206-753-9884
WYOMING	Address:	P.O. Box 59 Casper, WY 82602
	Phone Number:	307-261-5336

APPENDIX I

LITERATURE TO IDENTIFY RODENTS

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APPENDIX J

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NOTE: Additional generic revision, specific keys and species descriptions are too numerous to list.

APPENDIX K

STATE CONTACTS FOR RABIES INFORMATION

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